THE AMERICAN GAS LIGHT JOURNAL

REDMANKENNY, N.Y.

PUBLISHING OFFICE No. 32 PINE STREET

DEVOTED TO THE INTERESTS OF ILLUMINATION, VENTILATION, WATER SUPPLY AND DISTRIBUTION, & GENERAL SCIENCE.

VOLUME LXIII.—No. 27. Whole No. 1,073. | NEW YORK, MONDAY, DECEMBER 30, 1895 | $3 PER ANNUM, IN ADVANCE.

A. M. CALLENDER & CO., Proprietors. C. E. SANDERSON, Manager.
JOS. R. THOMAS, C.E., Editor. T. J. CUNNINGHAM, Asst. Editor.

ENTERED AT THE POST OFFICE AT NEW YORK, N. Y., AS SECOND-CLASS MATTER.

The Public Lighting Tables of the American Meter Company will be found in the page advertisement of that Company.

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[OFFICIAL NOTICE.]

Twenty-sixth Annual Meeting of the New England Association of Gas Engineers.

OFFICE OF THE SECRETARY, December 26, 1895.

The twenty-sixth annual meeting of the New England Association of Gas Engineers will be held at Young's Hotel, Boston, on Wednesday and Thursday, February 19 and 20, 1896.

The meeting will be called to order at 10 A.M., Wednesday, February 19. A good list of papers on timely subjects have already been promised. The subjects and authors will be announced later.

The topics for discussion which proved of so much interest last year will be continued this year, and several gentlemen have arranged to speak on the subjects already selected.

The Question Box will be a feature as usual. Members will please forward their questions as early as possible.

The members will dine together on Wednesday evening.

Application blanks may be had of the Secretary. Applications for membership, and all other matters for the consideration of the Directors, should be sent to the Secretary before Tuesday evening, February 18.

C. F. PRICHARD, Secretary.

THE RECENT DEPRESSION IN GAS STOCKS.

Following upon President Cleveland's message to Congress respecting the relations between this country and England in the Venezuelan boundary dispute, all stocks listed upon and dealt in on the Stock Exchanges of the various large cities were thrown upon the market and sacrificed at ridiculously low figures. In sympathy with those stocks whose ownership represented international holdings, other stocks, among them those of prominent American gas companies, went tumbling down, and were kicked about and their values depreciated in the unfortunate financial football game that usually follows the receipt of depressing news such as the President's message was supposed to convey.

Why gas stocks should be caught in the net is something of a mystery to us, particularly as this class of securities were almost without exception quoted at figures before the panic set in that but poorly represented their real intrinsic value. Such sterling stocks as Consolidated, of New York, and Chicago gas, showed a falling off in quotations of from 10 to 25 points, when though even the most adverse circumstances that could follow as a result of the severance of diplomatic relations between the United States and a foreign country would not affect the earning capacity of the plants nor the dividend paying values of the stocks representing them until long after actual hostilities were begun. We are led to believe that the trading was largely confined to speculative interests, and in no wise showed a desire to unload upon the part of those whose holdings were for investment solely, and who knew, as all shareholders should know, the real value of their possessions.

The revenues of a gas company are derived from local sources only, and until such time as our cities shall show a decided shrinkage in the transaction of ordinary commercial business and an appreciable decimation in their population, it is hardly likely that the gas companies' receipts will be considerably reduced. The raw materials required for the production of gas and the apparatus employed in its manufacture and distribution are without exception home products, and the points of their origin are so diversified that it is almost impossible to cut off their supply in every direction.

It is, perhaps, unnecessary for us to call the attention of well posted investors to the almost complete immunity of gas stocks from attacks to which many other securities are susceptible. To those who may have any misgivings as to the value of their gas investments, we would advise a careful consideration of all the conditions that might affect them, and we are safe in saying that they will almost invariably find that the dividends paid are such that an appreciable percentage of the net earnings goes to the surplus account.

We predict that as soon as the present excitement subsides, as it inevitably must, the prices quoted for the various gas stocks will rapidly advance and something like true values be reached. Investors, we hope, will have learned that there are no other classes of securities as gilt edged as these, and realizing their value as such, will so increase their holdings for investment account that gas stocks will command the respect they deserve, and be safe from such unwarranted attacks as we have been lately called upon to witness.

THE MUNICIPAL CONTROL OF LIGHTING PLANTS.

Of late an almost general tendency toward the municipal control of gas and electric light plants has developed. We are daily in receipt of information from widely divergent points, showing that the subject is receiving the consideration of the Common and Select Councils in the larger cities, and that the movement is extending so far as to command the attention even of the trustees of numerous townships and villages. Although we have not heretofore considered this subject seriously, believing that on the face of it the disadvantages and utter inadvisability of such municipal ownership would be so apparent that it would die a natural death, we now feel called upon to exert our influence against the consummation of all such projects, and to show wherein the manifest fallacy of investing municipal committees with the management of so important a public servant as artificial lighting plants exists. A consideration of the facts and figures before us proves that in cities and towns where the public and private supply of gas or electricity is in the hands of the municipal authorities, the service rendered is far below the standard when compared to that given by plants under private direction.

It is almost impossible to keep the management of municipal plants free from politics. In those cities which now have such plants we call attention to the fact that the administration of affairs is very much hampered by the executive heads being compelled to cater to the wishes of the representatives of the party in power. Positions must be found for their constituents, and in the distribution of patronage much material is forced upon the manufacturing department that is not only wholly unfit for the duties of the position, but seriously interferes with the proper discharge of the routine work devolving upon those who are experienced and are expected to accomplish the best results possible. It is not necessary to submit that a lighting plant, be it gas or electric, whose efficiency is dependent upon a uniform and intelligent observance of set rules and regulations, can be operated by a class of men who are mainly political "hangers-on" and whose only object in life is the occupancy of some soft berth requiring but little manual labor and absolutely no mental exertion.

The argument is always advanced that municipal ownership is for public good. It is represented that the manufacture and distribution of that necessary commodity, artificial light, can be more economically effected if the city or township is the manufacturer, because in that case there are no stockholders clamoring for dividends, and hence the amounts that are usually applied to this purpose will no longer be a charge against the earnings of the plants, but will go to the consumer in the shape of cheaper light. It is strange that any taxpayer will allow himself to be deluded by any such argument. Can he not see that, although his rate per 1,000 cubic feet may be less, his total expense, because of inefficient service, must be more? Can he not also see that any deficit due to a maladministration of affairs will be made up in the shape of additional taxes?

We know that the project would be short lived were it properly met, and wish to urge upon the management of gas companies in localities where municipal absorption or competition is being agitated, that the issue can be squarely confronted with such incontrovertible arguments as to defeat it in its incipiency. We offer the suggestion that, in Europe, where national and municipal control over what are private corporations in the United States is so general, lighting plants are a noticeable exception. We advise a more liberal policy in the administration of gas companies' affairs. While we believe that this question has arisen from other sources than public dissatisfaction, we do not hesitate to say that in some instances it has been invited by the gas companies themselves.

The manufacturers of electric lighting apparatus are the parties to whom we can attribute the now almost general consideration of municipal ownership. The field for the installation of their plants has become so limited that they are compelled to look to other than private capital for probable purchasers. Municipal corporations being now the most accessible, they are concentrating their efforts in this direction and are advancing the same theories and producing the same tempting figures in substantiation of them as were used when so many innocent and unsuspecting investors were induced to put money into local electric lighting plants not so very long ago. The almost universal failure of these electric light plants to wrest the supremacy from gas as a lighting agent and to return to their stockholders a fair dividend upon the capital invested is a matter of record, and we know could be used as potent factors in supporting the arguments of the gas men in resisting or arresting threatened municipal interference in the business of furnishing artificial light.

The Chemistry of Oxides Used in the Mantles for Incandescent Lighting.

The London *Journal* furnishes the following translation of an article by Dr. G. P. Drossbach, which forms the sequel to a previous article by the same author :[1]

Thorite has recently come into notice as a raw material, and appears in the market more often than it did. The supplies of Brevig, Arendal, Hitteroë and Champlain appear to have been quite exhausted; but it has been found elsewhere, and now can be purchased, with a content of 40 per cent. of thoria, at £17 10s. and under. Among recent analyses of thorite, Nilson's are the most reliable, and he found that selected crystals of the Arendal mineral contained: Silicic acid, 17.04 per cent.; phosphoric acid, 0.86 per cent.; thorium oxide, 50.06 per cent.; uranous oxide, 9.78 per cent.; lead oxide, 1.67 per cent.; ferric oxide, 7.6 per cent.; oxides of the cerium group, 1.39 per cent.; lime, 1.99 per cent.; magnesia, 0.28 per cent.; and water, 9.46 per cent.

For preparing pure thoria, Nilson takes the impure thorium oxide prepared by Berzellius's method, and converts it into sulphate by warming with concentrated sulphuric acid. This he dissolves in 5 parts of ice-cold water, and on warming the solution to 20° C. a copious deposit of snow-white thorium sulphate is thrown down. This operation is repeated until thoria of constant molecular weight is obtained. A single recrystallization may not be sufficient. The sulphates of the cerium group are soluble with difficulty in hot water, and are partially deposited with the thorium sulphate. The solubility of thorium hydrate in alkaline carbonates affords a rapid means of separation, care only being taken that the cerium is present as oxide, which is insoluble in dilute alkaline carbonates.

Recently an intermediate commercial product, known as thorium precipitate, has begun to compete with thorite. It is technically a hydrated thorium oxide, containing from 86 to 88 per cent. of the oxide, and is dealt in at about £14 10s. per pound, or £16 10s. per pound of thorium oxide. Compared with other commercial products, this hydrate is very pure, and it is therefore very easily worked up. A pure oxalate is obtained on precipitating a hydrochloric acid solution of the salt, and, by ignition, the oxalate is very easily converted into pure thoria.

Monazite still, however, is the most important material, and has only the above-named hydrate as an active competitor. The most varying qualities are found in commerce. Many dealers sell according to sample, but deliver very different materials; while others sell according to the percentage of monazite, trusting to the latter being estimated by the content of yellow nodules, which are not, however, all monazite. One Dutch tender is for 70 per cent. monazite at 8 cents per pound; but actually the sand often contains only 50 per cent. As methods of estimating the percentage of monazite are not established, I propose the following means of valuation.

The very finely powdered monazite sand is heated in a platinum crucible, with three times its weight of sodium potassium carbonates, until in a state of steady fusion. The melt is extracted with water; and silica separated from the aqueous solution in the usual way with hydrochloric acid. The insoluble residue is treated with concentrated sulphuric acid, and the sulphates dissolved in ice-cold water. [It is not practicable to dissolve the monazite in sulphuric acid at an earlier stage, as one treatment with the acid does not always break up all the monazite.] The residue is taken as chrome ironstone. Excess of oxalic acid is added to the sulphuric acid solution; and the precipitate formed is carefully washed, filtered, dried and ignited. One hundred parts of the oxides obtained correspond to 142 parts of monazite, as selected monazite crystals constantly yield 69 to 70 per cent. of the oxides. The filtrate from the oxalic acid precipitation is treated with ammonia, and the precipitate taken as foreigh oxides. It is evident that the determination of the oxalic acid precipitate is sufficient; but it is useful as a check to know the impurities also. The sum of the constituents usually amounts to 102 to 103, instead of 100, because by ignition a portion of the cerium sesquioxide is converted to cerium dioxide. In order that no didymium may remain in solution on the precipitation with oxalic acid, it is necessary that the original solution should not be very strongly acid, and especially that it should not contain a considerable amount of nitric acid.

Now that thorium oxide is very commonly dealt in according to its percentage, in which variations occur, it is desirable that there should be a recognized method of estimation. This must be based on the composition of monazite. According to Penfield, the thorium of monazite is derived from admixed thorite. He comes to this conclusion, because there is about the same proportion of silica to thoria in monazite as in

1. See Am. Gas Light Journal, Oct. 7, 1895, p. 507.

thorite. But my own experiments show that the whole of the thoria cannot be extracted with hydrochloric acid from very finely powdered monazite, as would be the case if it were present exclusively as thorite. According to Hidden, Kerr, Geuth, and others North American monazite sand contains the following minerals: Monazite, tetradymite, brookite, quartz, chromite, anatase, beryl, tourmaline, pyrope, zircon, epidote, fibrolite, columbite, samarskite, xenotime, montanite, fergussonite, rutherfordite, talc, tremolite, magnetite, limonite, menacanite, hematite, tellurium, asbestos, cyanite, corundum, rutile and actinolite. But as far as I have observed, only quartz, albite, chromite, magnetic iron ore, garnet, samarskite, aeschynite and zircon are present, though, of course, often in a state of impurity.

A complete analysis of so complex a mineral substance is not desired and, indeed, is scarcely practicable. Beyond the impurities of Brazilian monazite—consisting chiefly of quartz, chrome ironstone, magnetic iron ore and zircon—the estimation of the chief constituents must generally suffice. I propose the following as a method for general acceptance; it has proved satisfactory in more than a hundred analyses. The same course is pursued as in the estimation of the monazite, and the mixture of oxides of the cerium group is taken for further examination. Too high results would be obtained if the thoria in this mixture were estimated by Lecoq's method, as a portion of the cerium would be separated with it on precipitating from a neutral solution. It is better to proceed thus: The mixture of earths is intimately mixed with lamp-black, and heated in a stream of chlorine. Thorium tetrachloride volatilizes, while the metals of the cerium group remain as difficultly volatile chlorides. The thorium chloride so obtained (20 to 50 grammes of monazite are taken) is dissolved in water, acidified with hydrochloric acid; the solution is neutralized, and the thorium oxide is precipitated by Lecoq's method, by boiling with hydrated cuprous oxide. By again taking up in dilute hydrochloric acid, precipitating traces of copper with sulphureted hydrogen, and then precipitating the thoria with oxalic acid, and filtering, washing and igniting, pure snow-white thorium oxide is obtained. If the remaining oxides in the monazite are to be determined, the filtrate from the thoria precipitate is precipitated with oxalic acid, and the precipitate is purified with the bulk of the oxides of the cerium group, the oxalates being converted to oxides by ignition.

It is commonly supposed that the oxides of the cerium group may be separated from those of the yttrium group by precipitation with a concentrated solution of potassium sulphate. But Popp has proved that this separation is not only incomplete, but that oxides of the yttrium group are found in the precipitate of double sulphates. He was led by this to the erroneous conclusion that erbium is identical with didymium. In reality, nearly all the erbium goes into the precipitate on treatment with potassium sulphate, and the subsequent treatment leads to its inclusion with the didymium. A similar fate befalls scandium, terbium, and the yttrium group metals with absorption spectra—particularly decipium, samarium, Marignac's $Y\alpha$ and $Y\beta$ oxides, as well as thulium and holmium. It is not surprising that Kruss suspected the presence of a dozen metals in crude didymium. The solubility of the yttrium metals (as distinguished from cerium, lanthanum and didymium) in alkaline carbonates, was tried as a means of separation, but it was founnd generally that they remained in solution for a short time only, and were again thrown down tolerably soon.

My experiments indicate that these oxides may be retained in solution by using a very large excess of very concentrated potassium carbonate, in the presence of salts of ammonium. On acidification and addition of oxalic acid, the oxalates are thrown down. After careful washing, these oxalates are brought into a boiling saturated solution of ammonium acetate containing a surplus of undissolved salt, filtered while hot, and washed with a hot concentrated solution of ammonium acetate. The filtrate is very greatly diluted, and hydrochloric and oxalic acids are added for precipitation. There are thus separated from the filtrate a great quanity of oxalates of elements giving absorption spectra, while the residue on the filter contains, besides didymium, no oxalates giving absorption spectra. Let us call the residue on the filter *Y*, and the precipitate from the filtrate *E*. The first contains, besides cerium and a little didymium, a number of oxides of the yttrium group without absorption spectra; the precipitate *E*, all the elements yielding absorption spectra, besides traces of didymium, which, however, may be absent. *Y* and *E* contain a series of new elements, which may be traced by the recrystallization and fractional precipitation of some kilogrammes of these fractions, and amount to 20 to 30 per cent. of the mixture. Work on a very large quantity of these fractions (about 30 kilogrammes) is now in hand, and I would ask that this investigation should be left to me.

Schottländer has published some exhaustive work with regard to the separation of cerium, lanthanum and didymium. He states that the separation of cerium from lanthanum and didymium is best effected by Auer's method. I cannot confirm this, as I found Popp's system to excel it in simplicity and certainty. The neutral solution of the mixed chlorides is largely diluted, and sodium acetate and sodium hypochlorite added. As the cerium dioxide separates, the free acid must be neutralized. In this manner it is easy to obtain all the cerium. The separation of didymium and lanthanum is best carried out by Frerich's (*Deutsch. Chem. Ges.*, Ber. VII., p. 798) or Auer's (*Monatsh. Chemie*, IV., p. 630; V., p. 508) method. It would seem that, in all reported analyses of monazite, everything soluble in alkaline carbonates has been taken as thoria; everything not precipitated by potassium sulphate, as yttrium and erbium oxides, and the residue stated as oxides of the cerium group.

A large number of minerals, of which, until recently, few collections boasted specimens, are now found on the market in considerable quantities. For instance, I have in hand a quantity of auerlite—a mineral discovered by Hidden and Mackintosh. I believe it is a very pure orangite, as the proportion of phosphoric acid is not constant. Very large quantities of tscheffkinite lately came on the market from Virginia. This is a mineral of very complex composition, containing titanates of the rare earths. Gummite, containing thorium, is said to be found in Carolina; but, as far as I am aware, it is only obtained in Texas. Uranite containing thorium (and helium) is brought from Connecticut, and has recently been found in Bohemia very rich in thoria. Gadolinite is not in demand, and is very cheap. Yttrialite, with 8 to 10 per cent. of thoria, is obtainable in considerable quantities; and fergusonite, containing 3 per cent. of thoria, comes to the market in very large amounts.

Though sufficient to meet the demand, the quantity of thoria produced is still relatively small. Since thorite has again entered into commerce, very few firms work up monazite, and the price of it has steadily declined. The cargoes of monazite mentioned by E. Glinzer, which arrived at Hamburg, were for Vienna. All the Welsbach Companies procure their fluid from the Vienna firm for £5 per kilogramme nominally, and an additional payment of £2 per kilogramme until lately. The fluid (which is a nitric acid solution of the oxides) contains 280 grammes of nitrate per kilogramme, which is sufficient for 250 mantles. One kilogramme of the nitrate costs the Companies therefore £22 10s. to £25, while in the open market pure thorium nitrate still costs £27 10s. to £30 per kilogramme. One kilogramme of the nitrate will produce 900 to 1,000 mantles; so the cost for material is about 7d., and the total cost about 10d. per mantle.

The stoutness of the threads and the size of the mesh in proportion to the mantles, is important in the manufacture of the latter. In good specimens, the thread is 0.2 mm. (0.0079 inch) in thickness, and it should be of absolutely pure cotton, as free from ash as possible. Mantles which come on the market at a price of about 1d. are quite unsuitable for use. Their content of ash is far too great, and filaments purified with hydrochloric and hydrofluoric acids cannot be made at the price. For really durable mantles, fulfilling the highest claims, a thorough preliminary purification of the filament is indispensable. Absolutely pure thorium nitrate occurs in commerce, and may be mixed with one-fourth to one-fifth of terbium and yttrium nitrates, and applied as a 30 per cent. solution. For a greenish light, an addition of 5 per cent. of erbium nitrate is necessary; for a yellow light, lanthanum nitrate. Moreover, the kind of burner has a considerable influence. The original Welsbach burners are, perhaps, the most unfavorable to the light. The mantle only is far superior to all others. The Welbach burner gives, with good gas, a flame only partially luminous if the chimney is removed. Many burners considerably raise the efficiency of the Welsbach mantle. It is only a technical question how to increase the intensity of the development of heat sufficiently for the employment of the cheaper oxides allied to zirconia for incandescent lighting.

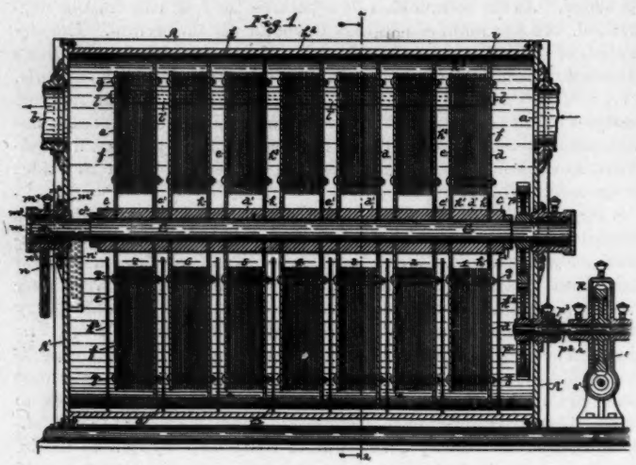
Gas Washer and Scrubber.

United States Letters Patent (No. 551,694), dated December 17, 1895, have been granted to Frank L. Slocum, of Pittsburgh, Pa., assignor of one-half to James Gardiner, Jr., for improvements in gas washers and scrubbers. Using the words of the specification:

My invention relates to apparatus for scrubbing gases, and, as it might be termed, to apparatus for "washing," "purifying" and "condensing" gases or vapors, the invention relating to certain improvements in the gas scrubber having a series of perforated plates or

disks which revolve in absorbent liquid, and through the upper part of which the gas passes in a substantially horizontal course, and also to certain improvements in the general class of scrubbers set forth in Letters Patent to Kirkham *et al.*, No. 206,736, dated August 6, 1878.

In the first class of rotary gas scrubbers two difficulties have been



encountered, one the proper sealing or closing of the space between the rotary portions of the scrubber and the inclosing case and where the gas passes through the same, so as to prevent a current of gases passing around the plates without coming in contact with the absorbent liquid, it being found that the gases will naturally seek such an outlet. Another difficulty in the class of scrubbers shown in said patent No. 206,736 is in the friction between the surfaces necessarily bearing on each other to prevent the passage of the gases between such surfaces, such as the friction of the rings against the faces of the partitions which divide the scrubber into the different compartments through which the gas is caused to flow outwardly or radially between the series of plates. It was necessary to hold these plates together, and it was also necessary to make a substantially tight joint between the partitions and the bosses or rings confining the lower edges of the cluster of plates. This requirement led to the creation of such an amount of friction that considerable power was required to rotate or operate the scrubber, and in the end the sets of disks were often loosened from the central shaft, and instead of rotating on said shaft would simply rest thereon and would quickly cut the shaft out and render the scrubber inoperative.

One of the objects of the present invention is to improve this class of rotary scrubbers so as to overcome this difficulty.

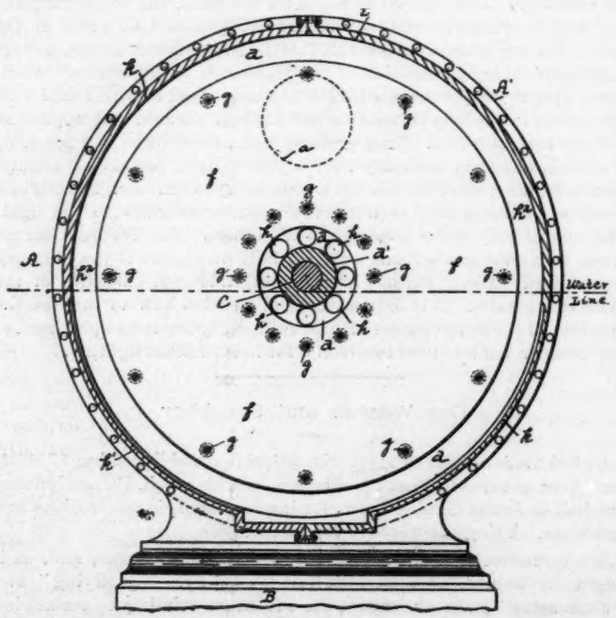
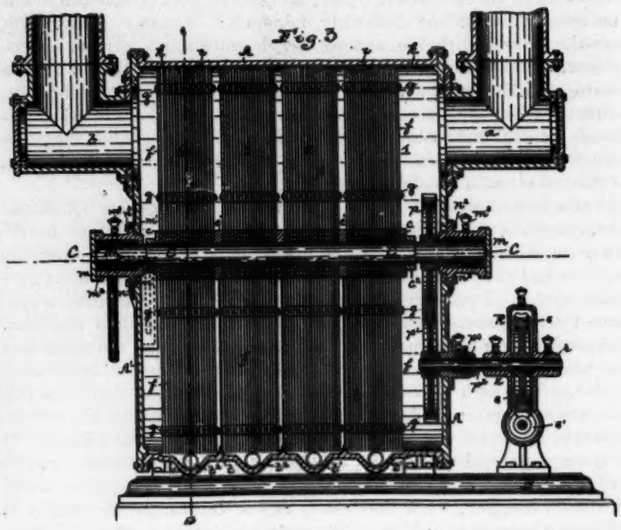


Fig 2.

Another object of the present invention is to improve the method of applying the power so as to prevent leakage of the gas, as there are no



moving parts having journals through which the gases could escape.

The particular points of the invention desired to be covered will be hereinafter set forth and claimed.

To enable others skilled in the art to make and use my invention, I will describe the same more fully, referring to the accompanying drawings, in which Fig. 1 is a longitudinal central section of a gas scrubber of the general class referred to in said patent, and Fig. 2 is a sectional view on the line 2 2, Fig. 1. Fig. 3 is a longitudinal section of a gas scrubber formed of a series of perforated plates or disks, and Fig. 4 is a sectional view on the line 4 4, Fig. 3, the perforations through the disk being indicated at different points, and it being understood that the disk is perforated throughout. Like letters and figures of reference indicate like parts in each view.

I will first describe the invention in connection with the class of scrubbers referred to in said patent, in which the gases are required to pass to the central portion of the scrubber around the central shaft or hub, and thence in a zigzag course outwardly or radially through a series of plates and back to the central portion, this course being followed throughout the scrubber, and the gas being purified by being brought into contact with the liquids held between the plates which are immersed in the lower part of the scrubber in the absorbent liquid and carry the same up so that the gases in passing between the plates

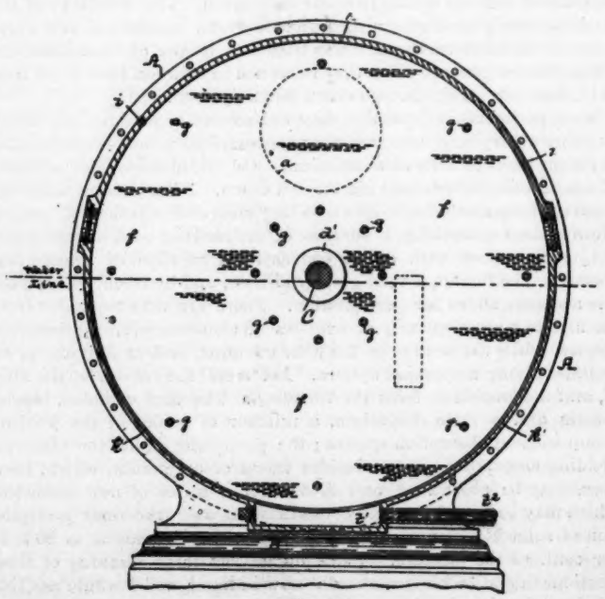


Fig 4.

are necessarily brought in contact therewith, and the ammonia or other materials to be absorbed are taken up by the liquids while the gases are condensed and cooled by contact with the same.

The object of the present invention, so far as it relates to the construction above indicated, is to provide a gas scrubber of that construction in which the necessity of the partitions between each cluster of plates is overcome, and in which there are no such frictional faces between such partitions and the bosses confining the lower ends of the plates, and therefore in which such frictional action is entirely done away with. To these ends I employ a case *A* having a gas inlet *a* and a gas outlet *b*, and I mount in the same the central shaft *C*, the method of mounting the same being hereinafter described. Upon that shaft I secure at intervals the end plates of each series or cluster of plates, mounting each set or series directly upon the shaft, and clamping the whole together as illustrated in Fig. 1—that is to say, taking, for example, the first cluster of plates, near the entrance *a*, upon the shaft is a collar *c*, which can either form part thereof or be secured thereupon, and one of the supporting plates *d* is placed against that collar, said plate *d* resting directly upon the shaft *C* and against the collar d^1, and being confined by another collar e^1.

Suitable engraving devices between the shaft and the supporting plates and collars, and between the supporting plates and collars themselves, so as to secure them rigidly together, may be employed, so that the whole body is held rigidly to place. Between the said supporting plates *e* and *d* are secured the series of disks *f*, which are clamped between the supporting plates *e d* by the bolts *g*, which are arranged at suitable intervals, and so secure the disks between the supporting plates. These disks may be made of sheet or plate metal, of suitable thickness, and are held apart a distance of about one-eighth of an inch by means of the slight projections formed in the plates by blows at intervals thereon, forming indentations on one side and slight projections on the other.

It will be seen that the plates *d* have the openings *h* formed therein just above the collars *c* d^1, and that the disks *f* do not extend down to the collars, the space or chamber h^1 being left between the two.

It will also be seen that the outer edge *i* of the supporting plate *d* fits closely to the inner face *k* of the casing that is in the upper part thereof, so that the gas cannot escape around the upper end of the plate *d*, and therefore will flow down to the openings *h* into the chamber h^1, and will then rise between the disks *f* to the outer end thereof, entering the chamber h^2. The plates are arranged in clusters around the shaft, spaces being left between the plate *e* and the plate *d* of the next cluster, so as to form a downtake passage or chamber h^3, through which the gases will flow downwardly to the opening *h* leading into the space h^1 at the base of the next cluster. The chamber h^2 may be filled with a series of disks, if desired, but that is not considered the preferable construction. The plate *e* is formed imperforate at the lower end, so as to form the confining wall for the chamber h^1, but it does not extend out to the face *k* of the outer wall or casing, so that the gases can flow around the outer end of said plate *e*, and thence inwardly through the chamber h^3 into the chamber h^1 of the next cluster 2. The course of the gases is thus arranged through each cluster entering the chamber h^1 through the openings *h* in the plates *d* and passing outwardly between the disks *f* into the chamber h^2, and thence inwardly through the chamber h^3 to the next cluster of plates or disks. In order to mount these clusters upon the shaft, I employ the same construction above referred to, each supporting plate *d e* resting upon the central shaft and being clamped between the collars d^1 e^1, the collars d^1 corresponding in width to the cluster of disks *f*, while the collars e^1 correspond in width to the spaces h^3, the whole being clamped firmly upon the shaft *C* and held in place by the outer collars *c* and by suitable nuts c^2. I also find it desirable, though not necessary, to carry one or more bolts throughout the entire cluster of plates, as shown by *l*, a long bolt passing through each cluster and having sleeves or collars l^1 fitting around the same in the spaces h^3. In this way the entire mass of plates is properly clamped together, not only at the center, but at the outer ends thereof. I am thus enabled to provide a rigid mass of plates securely clamped together and having no frictional contact with any surface, and yet obtain the same results as found in the ordinary washers, such as shown in the patent above referred to.

It will be seen, of course, that for the purposes of practicing the invention in the way above described, it is necessary to provide a practically gas-tight joint between the series of plates *d* and the upper part of the washer through which the gas passes, and this applies as well to the class of washers formed of a series of perforated plates or disks as in connection with the washer just above described. For this purpose I provide an accurately turned closed joint between the outer edges of the plates and the body of the casing, so that the plates may be brought in such close proximity with the walls of the casing that a water-film joint may always be maintained between the plates and casing. This is accomplished in the following way: As shown in Figs. 2 and 4 the upper part of the casing *A* (which casing can be divided into any number of sections desired) is turned accurately from a point at the line of the central shaft *C* throughout the entire upper portion thereof, this being done by suitable machinery so as to bring the same accurately to the desired size and curve for the face *k* thereof. The lower part of the casing *A*, which is filled with the absorbent liquid, is not turned to such face, but leaves space for the flow of the liquid around the ends of the plates, a depression k^1 being formed around that portion of the case, and the lower part of the casing being divided into a series of compartments by the partitions k^2. The outer edges of the plates which are to form the joints with the casing are also accurately turned to the proper size after they are mounted upon the central shaft, so as to bring them to the exact size required—that is, to such size as will enable the plates to fit so close to the face *k* that a film of water or other absorbent liquid will always be maintained between the edge *i* of the plates and the inner face *k* of the casing. Practice shows that this joint, while not that of actual contact and friction, can be made so close that the water carried up by the edges of the plates will always maintain a film or water joint between the plates and the face *k* of the casing, so that the gases cannot pass around the same. It is evident, however, that in the erection of the machine it will be practically impossible to bring the parts into that exact position, and to enable this to be accomplished. instead of making the bearings *m* for the shaft *C* rigid with the casing, *I* form the same adjustable therein, so that after the closing of the casing the shaft can be raised and bring the edges of the plates into the exact position proper for maintaining the joint between the edges *i* thereof and the face *k*. This is shown in the drawings, Figs. 1 and 3, in which the bearing-block *m* is secured to the end wall A^1 of the casing by the flanges m^1 through which bolts pass, the casing having the shoulder *n* below the seat n^1 on the flange m^1 of the bearing, and through said shoulder *n* the set-screw n^2 extending so as to bear against the flange of the bearing *m* and provide for the accurate adjustment of the same.

Suitable metal or packed joints may be employed between the casing and flange m^1 of the bearing so as to prevent leakage of the gas. The bearings *m* are also made closed and gas-tight so that there can be no leakage through the bearings, this being preferred, and the power being applied to rotate the shaft *C* in another way so as to overcome the necessity of stuffing-boxes and the necessity of such tight packing for the shaft as would create friction in the rotation of the same.

The bearings *m* may contain suitable brasses or bearing blocks m^2, and the oil may be fed thereto through the oiling cup m^3.

After the casing has been closed around the shaft, and when the machine is ready to be put in operation, the shaft is accurately adjusted within the casing by the loosening of the bolts connecting the bearings to the casing, and the adjustment of such bearings through the set screws n^2, so as to form such exceedingly close joint between the plates and the inner face *k* of the casing, the shaft being raised and adjusted to give this result.

It is evident that another source of leakage of the gas from these rotary scrubbers is found in the driving of the main shaft thereof through the stuffing boxes just above aluded to, and also that it is easier to maintain a water-tight joint than a gas-tight joint, and for that purpose I have arranged to drive the central shaft *C* in the following way: Upon the same I place the gear wheel *p*, which meshes with the gear wheel p^1 upon the shaft p^2, which shaft extends through the stuffing box p^3 in one of the end plates A^1 and below the water line of the scrubber. The shaft p^2 is mounted in suitable bearings *r* formed in the frame *R*, which is secured to the foundation *B* of the machine and within which frame *R* is the worm wheel *s* which is secured to the shaft p^2, said worm wheel being driven by the worm s^1 mounted in the frame *B*, while to the shaft carrying said worm power can be applied by any suitable means, either directly by the engine or by connections from any other suitable source of power. In this way, even in a large scrubber, it is found that the same can be driven at the expenditure of practically no power, the different plates clamped upon the main shaft being arranged to practically balance each other, and said shaft being mounted in the bearings generating little or no friction, and the power being applied to the same through a joint which does not require to be more than usually tight, while the outer edges of the plates form close joints with the inner face of the casing but do not actually contact therewith, and there is practically no friction in the rotation of the series of plates. The water or other liquid can be fed to the casing in any suitable way

by suitable goose neck or other like pipes and carried away from the same in the same way.

In the scrubber, formed of a series of perforated plates or disks, I generally prefer to separate the lower part of the casing into a series of chambers by the vertical partition plates *t*, and at the bases of the chambers so formed are pockets t^1 to receive any tar or like condensable matters which can be conducted from the same through the pipes t^2.

In the operation of scrubbers of the construction shown in Figs. 1 and 2, gas enters through the port *a*, and flowing down, enters through the openings *h* into the chamber h^1 and rises between the plates or disks *f* into the chamber h^2. The plates are rotating within the liquid contained in the bottom part of the casing, and as they rotate their surfaces are coated with the water or other absorbent liquid, and it is evident that the gases passing up between these plates are brought into contact with the same which is flowing downwardly over the plates as soon as they rise from the body of the liquid, and it is therefore evident that the gases must be brought into contact with the absorbent liquid, and that the liquid will act to absorb from the same the ammonia, benzol or other vapor desired to be recovered. This operation will continue between each set or cluster of plates, and by the time the gases reach the other end of the apparatus and flow through the discharge pipe *b* practically all of the ammonia or other materials desired to be recovered will be absorbed therefrom, and at the same time any other condensable matters, such as tar, found in the illuminating gas, will be deposited by the gases and collect in the bottom part of the apparatus. The seal or joint between the plates *d* and the inner face *k* of the casing will be maintained in the manner above described by the film of water on account of the close meeting of the edges *i* of said plates with said casing, yet as there is not an actual contact there will be no friction between such parts.

In the operation of the apparatus shown in Figs. 3 and 4, the several plates are placed close to each other, and are perforated with numerous small holes, such as shown in Fig. 4, these holes being made in one plate opposite the solid portions of the adjoining plate, and these openings being made in the one plate opposite the blank spaces in the adjoining plate, and as the plates pass down into the liquid the liquid is taken up thereby and held in these small openings or perforations, so that as the gas strikes against the same it will be brought in contact with the liquid and will be compelled to force the liquid out of the perforations in many cases, and the gases will in this way be compelled to pass through each plate and strike against the adjoining plate in their course from the entrance to the delivery end of the apparatus, while the liquid so forced out of the perforations will be sprayed in such way as to to descend between the plates and act as a water spray to further absorb the desired vapors from the gases. The joints *i* of all the different plates against the face *k* of the casing in the gas space thereof will be maintained in the manner above described.

What I claim as my invention and desire to secure by Letters Patent is:

1. In gas washing or scrubbing apparatus, the combination of an inclosing case having inlet and outlet ports, a horizontal rotary shaft mounted therein, and a series of plates secured to that shaft within the casing and held sufficiently close to the inner face of the casing to form a film joint between the said plates and the inner face of the casing, substantially as set forth.

2. In gas washing or scrubbing apparatus, the combination of an inclosing case having inlet and outlet ports, a horizontal rotary shaft mounted therein, a series of plates secured to said shaft within the casing and held sufficiently close to the inner face of the casing to form a film joint between the said plates and the inner face of the casing, and bearings for said horizontal shaft made separate from the casing and adjustable thereon, substantially as set forth.

3. In gas washing and scrubbing apparatus, the combination of an inclosing case, a horizontal shaft mounted therein and carrying a series of plates or disks, said plates or disks being supported sufficiently close to the inner face of the case to form a film joint therewith, bearings formed separate from and secured to the end plates, said bearings having flanges and the end plates having seats for said flanges and shoulders below the flanges through which set screws extend to engage with the flanges, substantially as and for the purposes set forth.

4. In gas washing or scrubbing apparatus, the combination of a case having inlet and outlet ports, a cental shaft, supporting plates rigidly secured thereto and supporting a cluster of annular discs, one of said supporting plates fitting closely to the inner face of the outer casing and having openings close to the central shaft, and the other of said plates extending up to the upper ends of the cluster of disks confined between the two supporting plates, substantially as and for the purposes set forth.

5. In gas washing or scrubbing apparatus, the combination of a case having inlet and outlet ports, a central shaft, a series of clusters each formed of two supporting plates rigidly secured to the shaft and supporting a series of annular plates or disks, one of said supporting plates fitting closely to the inner face of the outer casing and having openings close to the central shaft, and the other of said plates extending up to the upper ends of the cluster of disks confined between the two supporting plates, said clusters being separated from each other so as to leave spaces for the passage of the gas, substantially as and for the purposes set forth.

6. In gas washing or scrubbing apparatus, the combination of the casing having inlet and outlet ports, the central shaft mounted therein, the supporting plates *e d* rigidly secured to the said shaft and supporting a cluster of annular disks confined between the same, the plate *d* having the openings *h* and the cluster of disks being supported some distance above such openings so as to form the central chamber h^1 and said disks extending toward but not contacting with the outer casing so as to form the chamber h^2, substantially as and for the purposes set forth.

On the Alleged Escape of Carbonic Oxide and Unconsumed Carbon from Coal Gas Flames.

By Lewis T. Wright.[1]

In years gone by, a very popular charge brought against coal gas lighting was the occurrence of certain oxidized sulphur compounds among its normal combustion products; but it has been left to quite recent times to discover in those products the toxic carbonic oxide, of which a very trifling amount would render the air we breathe positively dangerous, since its effects are cumulative in destroying the oxygen absorbing capacity of the blood—a property upon which the animal economy depends. There also appears in certain quarters to be some tendency to revive an old scare of the passage of this deleterious compound through the iron of heating stoves and their flues. This latter danger was much more felt in those countries where the iron stove with charcoal and coke as fuel is more popular than our open coal grate, and became the subject of serious inquiries, resulting in the conclusion that carbonic oxide did actually pass through cast and wrought iron, *but only when these were heated to redness.* As the gas stoves in use do not commonly become red hot, either in their iron bodies or their flues, the danger of the contamination of the air of our apartments by these is not to be apprehended, *even if the products of combustion of the gas consumed in them did normally contain carbonic oxide.* There is also the efficient practical test of time and use, which abundantly proves that coal gas can be consumed in dwelling rooms without giving rise to any evil effects. In spite of this general and proved immunity from the toxic effects of imperfect combustion of coal gas, we are all aware that, under certain circumstances, the atmospheric gas flame will—if it light back, for instance, or if it be placed so as to be unable to obtain sufficient air—give products of incomplete combustion. But these circumstances are abnormal and can be avoided; and, further, should they arise, the evil smell of the imperfectly consumed gas would give immediate warning.

The publication by M. Gréhant of the results of some investigations showing that the products of combustion of the Auer burner contained carbonic oxide, caused some excitement among our Continental neighbors, especially as he stated that the products of combustion of lighting gas should be avoided, more particularly those emitted by the Auer burner. This was a very serious statement, coming from a chemist whose work on the detection of carbonic oxide in the blood was well known, and it could not be allowed to pass without criticism. Profs. Renk and Boshard carried out elaborate investigations, and were not able to detect the presence of the deleterious impurity among the products of combustion from the Auer burner; and Dr. Bunte, in June of this year, in an otherwise valuable memoir, since it relates to other matters, such as the durability of mantles, etc., found that, with copper oxide, the indications of imperfect combustion were so slight as to be within the limits of experimental error. The gas burners tested by Bunte were the Welsbach, Argand and flat flame. M. Gréhant had, in the meanwhile, so modified his statement as to say in a later paper that the use of the Auer (Welsbach) mantle is unattended with any danger of poisoning by carbonic oxide; and this incident of the supposed danger to health attending the use of incandescent gas burners may now be considered as closed.

1. *London Journal*, Nov. 19, 95.

In a paper read by Professor Vivian B. Lewes before the Chemical Society, it is stated that from the tip of a flame (the class of flame is not mentioned) there escaped unburnt 0.39 per cent. of saturated hydrocarbons and 1.18 per cent. of carbonic oxide. It is an exceedingly difficult matter to collect for analysis the gases from any part of a flame or its immediate neighborhood so as to enable one to state with certainty that they represent the gases that would be present at that particular point if the suction tube were not there in operation. Landolt, in his classical investigation, "Ueber die chemischen Vorgänge in der Flamme des Leuchtgases," made at the suggestion of Professor Bunsen in the latter's laboratory, analyzed the gases collected at various parts of a rat-tail flame about 100 mm. in height. He placed the fine suction tube used for the collection of the samples vertically in the axis of the flame, and found that the small amount of suction required to draw the gases through the apparatus reduced the length of the flame about 10 mm.; and he was not able to continue his investigations on the composition of the flame gases beyond a height of 50 mm. above the bottom of the flame, on account of the obstinate obstruction formed by the free carbon. He found that a fine wire passing through the suction tube used for clearing it of this deposit, caused an inconvenient deformation of that flame. It is probable that the gases escaping from the tip of the flame in the experiment cited by Professor Lewes were really drawn from an integral part of the flame *before the combustion was complete*, and do not represent the gases escaping from it.

The experiments made by Mr. W. Thomson, and described by him to the British Association in 1890, on the gases escaping unconsumed from various burners, both lighting and heating, are of a very circumstantial character, and would indicate that combustion was not, in the cases under investigation, so complete as might be desired. He adopted the method of drawing them, after removal of the carbonic acid and water, over heated copper oxide, and determining the further amounts of carbonic acid and water formed by the complete oxidation of the combustion gases. This method, unless by blank experiments it be found that the atmosphere, quite apart from the gas flames experimented upon, is free from carbon containing compounds other than carbonic acid, is somewhat uncertain, as, where there are gas pipes and connections, it might happen that there would be some slight escape of coal gas into the atmosphere, quite independent of the flames employed; and this would be classed as coal gas escaping from the burners unconsumed. In Mr. Thomson's experiments, no attempt was made to show in what form the (in certain cases) very important quantities of unconsumed gas existed; and it would not therefore be correct to classify his trials among those that have shown carbonic oxide as an ordinary constituent of the gases leaving coal gas flames. He merely proved that, in some of the cases studied, there were important quantities of carbon and hydrogen, not oxidized to carbonic acid and water, escaping from gas stove burners. The following is a recapitulation of his results:

Carbon and Hydrogen Escaping Unconsumed per 100 Parts of Carbon Completely Burned.

	Carbon.	Hydrogen.
Petroleum lamp not burning at the full	—	—
Do. with flame turned full on	1.204	0.309
Argand gas flame	—	0.025
Do	0.011	0.254
Bray burner, consuming 4 cubic feet per hour	1.112	0.095
Welsbach burner	1.500	0.379
Marsh Greenall's heating stove, burning 5.62 cubic feet per hour	1.260	0.300
Do., burning 5.74 cubic feet per hour	3.760	1.180
Do., burning 7.10 cubic feet per hour	9.740	1.210
Thomas Fletcher's heating stove, with eight Bunsen burners	4.330	2.460
Do., burning 6.81 cubic feet per hour	6.630	2.000
Do., with 20 Bunsen burners, with asbestos and fireclay back, consuming 8.14 cubic feet per hour	13.890	1.170
Heating stove	20.000	—

The amount of unconsumed carbon found in the one case of the Argand burner is too small to form the basis of a definite conclusion. It was represented by an increase of weight determined in a chloride of calcium weighing tube of about 0.004 grain. The quantities of imperfectly consumed carbon escaping from the heating burners used in the various stoves examined by him are far from being unimportant, even if no portion of it existed as carbonic oxide. That so much as 20 parts of carbon per 100 parts completely burned should escape from any gas burner is almost incredible, and is quite opposed to the writer's experience. It is curious that the Argand burner, which is of a class that, under abnormal conditions—viz., when turned on too full—gives large quantities of unconsumed gas, is precisely the burner that, under normal circumstances, has been shown by those investigators, like Gréhant and Thomson, who have found important quantities of unconsumed gas escaping from other burners, to be the one freest from suspicion.

The inquiry carried out in the *Lancet* laboratory, by a special Analytical and Sanitary Commission, on the products of combustion from Welsbach, Argand and Bray burners, gave a distinctly negative result as regards the occurrence of carbonic oxide and acetylene in the combustion products from the two former, and but a very doubtful indication of their presence in those from the Bray burner. The experiments were conducted under severe conditions, for the burners were placed in a "small chamber 3 feet 1 inch by 3 feet 1 inch by 2 feet 4 inch (with no provision for any appreciable ventilation or outlet for the gases) for 8 hours, during the whole of which time the air taken from above the burners was aspirated first over potash and soda lime to remove carbonic acid and sulphur compounds, then through sulphuric acid to remove ammonia, and finally through a dilute solution of blood." Only in the case of the Bray burner was there the slightest indication of carbonic oxide. Nor could acetylene be detected in the case of the Welsbach and Argand burners, and the indication given by the silver nitrate test on the products from the Bray burner was at the best "doubtful." The result of the inquiry was thus entirely satisfactory in dispelling any fears as to the occurrence of the poisonous gases, carbonic oxide and acetylene in the combustion products from such burners. The blood test applied for the former compound is positive, as it depends upon certain changes in the character of the blood as revealed by the spectroscope—changes which are only caused by carbonic oxide; and it is capable of confirmation by the after-expulsion of this gas from the blood in which it has been collected, and its examination by other reagents that would give further proof of its presence.

The writer has on two different occasions sought for, and endeavored to find, traces of unconsumed gas escaping from the normal flames of ordinary gas burners, both lighting and non-luminous. The atmosphere of an imperfectly ventilated apartment, where there is much gas being consumed, is unpleasant; but it does not follow that there is on that account unconsumed gas leaving the flames. On the occasion of fitting up the large show room of gas appliances installed by the Gas Committee of the Nottingham Corporation, he tested a considerable number of cooking burners, in order to ascertain whether, in their normal condition, there would be any traces of unconsumed gas leaving their flames, and he invariably obtained a negative result. The writer has always contended that it is necessary, wherever possible, to arrange gas flames in such a manner that the products of combustion should discharge themselves directly into the outside air, not because such gas flames imperfectly consume the gas, but on general considerations of comfort; and it was for this reason that he provided a system of flues whereby every gas stove or gas fire, etc., which was on exhibition, and which would from time to time be shown in action, was attached to a flue, wherein was always maintained a constant draught discharging itself into the outer air.

The burners were tested in the following manner: They were placed in a small room, the air of which was tested in order to ascertain that there were not present any carbon compounds (escaping coal gas) that would give the reaction sought for. A tube was placed over the flames (but so as not to touch them), and the products of combustion, mixed probably with some air, were drawn through vessels containing cotton wool, to remove dust, organic matter, etc., and then through a column of soda lime, to remove the carbonic acid. The gases so purified were afterwards passed over copper oxide that had been prepared *in situ* by the oxidation of fine copper wire, and then through bulbs containing lime water. The results were in all cases negative, and not the slightest trace of carbonic acid formed by the oxidation of carbonic oxide or other products of unconsumed coal gas could be detected.

On another occasion, on discovering the facility with which the inner or primary flame of the atmospheric (or Bunsen) flame could be separated from the outer cone or secondary flame, and, when so separated, the ready extinguishability of the flame, which then is represented by partially consumed gases containing as much as 11½ per cent. of carbonic oxide, it appeared to the writer that there might be danger from a too large pre-admixture of air to the Bunsen flame (approaching the mixture when the flame might strike back). Therefore his previous experiments with large Bunsen flames were repeated in this condition of maximum air supply, and again with negative results.

Coal gas has now been used in enormous quantities for a number of years, and in badly ventilated rooms and workshops, and there have been no cases of poisoning from the unconsumed gas leaving the burners. The action of carbonic oxide on the blood is distinct, as it forms a

compound with the hæmoglobin, and can even drive out the oxygen from the oxy-hæmoglobin, forming the carbon monoxide hæmoglobin compound from which the carbonic oxide cannot be afterwards displaced by oxygen. It is in the highest degree improbable that, if there were any such imperfect combustion from lighting burners as has been suggested by the analytical results of the various observers mentioned, considering their great variety, and that many of them are sufficiently bad, the fact would have only been recently discovered, for, in the earlier years of gas lighting, there were critics quite as well informed and quite as willing to discover defects and imperfections in the popular illuminant as there are to-day.

The weight of scientific and practical evidence is entirely against the view that carbonic oxide escapes from the flames used for lighting. It is possible to conceive a variety of circumstances in which the burners employed in heating are unable, by lighting back, or by being confined in a flue or chimney of too small capacity, to procure the quantity of air requisite for the normal combustion of the gas passing through them; but given a free air supply, the worst burner seems to have no difficulty in completing the combustion of the gas. Before accepting any evidence based on analytical methods, it will be necessary to show that these are above reproach; and in cases where the products of imperfect combustion are found in but very minute quantities, it will be more satisfactory to prove, by blank experiments, that such minute quantities would not be found if the suspected flames were absent. In any case, the writer does not believe that an instance of imperfect combustion has ever been substantiated against lighting burners, nor even against heating burners of good class when employed under their normal working conditions.

Shrinkage of Cast Iron and Molecular Structure.

By Jacob Reese.[1]

A bar of iron is not a continuous body. It may be physically divided. The end of physical division is the molecule. Molecules may be further divided by chemical action. The end of chemical action is the ultimate atom.

Atoms *per se* are inert. They derive their energy from the physical forces—that is, the static force which is inherent in the atoms and tends to draw them together and hold them in a state of rest, and the dynamic force which accompanies the atoms and tends to push them out into a state of activity. By virtue of these forces the atoms unite and form molecules and the molecules assume a physical structure, in which neither the atoms in the molecules nor the molecule in the physical structure touch each other, nor are they at any time inan absolute state of rest.

When the molecules increase in activity they require more room and when their activity is decreased they are drawn closer together. We are thus enabled to determine the molecular activity of any body by its temperature, for temperature is a phenomenal measure of molecular activity as weight is the measure of matter.

The atoms of each elementary body unite to form molecules in definite numbers called chemical equivalents. The molecule of hydrogen is composed of 2 atoms, carbon 12, oxygen 16, sulphur 32, iron 56, silicon 23, manganese 55; the highest being thorium, having 238. The energy exerted by the inherent static force varies in different elementary bodies. The static force being inherent, its effective force will be inverse to the disiance of the particles from each other. Whatever the effective force may be, it is always balanced by an equal amount of the dynamic force; this effective force so balanced is known as the molecular resultant force.

We thus learn that each elementary body possesses a different inherent static force and consequently a different molecular resultant force, and as the molecular resultant force is the measure of tensile strength, it will be seen that every additional degree of an element in a compound body will produce a corresponding change in its tensile strength.

When the molecular resultant force is sufficient to hold the molecules in a local relation to each other, the matter will be in the solid state, but when the molecular resultant force is reduced below the force of gravity, the molecules gravitate into the fluid state and become mobile, and when the molecules and the atoms composing them become so distended that their specific gravity is diminished below the specific gravity of their surrounding medium, the matter then assumes the gaseous state.

We thus learn that the state of matter, as well as the molecular resultant force, is determined by the molecular activity, and that the molecular activity of any mass of matter is the sum of the molecular activity of the elements composing it.

I have thus endeavored to show that the expansion, contraction and tensile strength are caused by and are phenomenal indications of the molecular activity of the metal; that each elementary body possesses and exerts a distinct inherent static force, a distinct molecular resultant force and its relative degree of activity; that increased activity causes expansion while decreased activity causes contraction, and both of them produce corresponding changes in the tensile strength of the metal.

In the molecule of iron there are 56 atoms, and as the atoms are presumed to be of the same shape as the earth, there exists between adjoining atoms what are known as chemical pores. Now if these pores are empty and the specific gravity of the iron be 7.894, if we inject carbon into these chemical pores, while it will increase the molecular resultant force, it will also require room and expand the molecule and thus reduce the specific gravity of the metal, and this appears to explain the fact that steel, though twice as strong, is lighter than iron.

As a matter of interest to your readers, I give the effect of carbon on the specific gravity of iron:

Specific gravity of wrought iron							7.894
"	"	"	steel	0.33	carbon		7.871
"	"	"	"	0.42	"		7.867
"	"	"	"	0.48	"		7.855
"	"	"	"	0.58	"		7.852
"	"	"	"	0.63	"		7.848
"	"	"	"	0.74	"		7.847
"	"	"	"	0.84	"		7.840
"	"	"	"	1.00	"		7.836
"	"	"	"	1.25	"		7.823
"	"	cast iron		4.50	"		7.204

1. In *Iron Trade Review.*

The Limits of Electric Power Transmission.

By Alton D. Adams.[1]

In every branch of engineering there is a wide difference between the physical possible and the commercially practical, and the electric industry has suffered repeatedly from a failure to recognize this fact. During the past year much has been written which might leave the impression that the electric transmission of power over very considerable distances, up to several hundred miles, is a commercially practical undertaking; and that power from Niagara Falls or the coal fields of Pennsylvania can be delivered at the large cities of our Eastern States at a good profit to the promoter.

The electric transmission of power over various distances up to about 100 miles has been carried out in several cases, but data showing the cost per horse power year of power delivered over such distances are very scarce. While these long-distance transmissions may form attractive experiments, it must be demonstrated that it is possible to thus deliver power more cheaply than it can be generated at the point of use, before they can become common. The cost of transmitted power increases with the distance, and it is obvious that, assuming absolutely free power at the start, a distance may be chosen great enough to consume its entire value in cost of transmission. To make, then, the transmissions of power commercially practical, it is necessary that the cost of transmission be less than the difference between the value of the power at the starting point and its value at the point of delivery.

As steam power is the one generally available in cities, its cost may be fairly taken as that which the total cost of transmitted power must not exceed. In the selection of a figure for the cost of steam power in cities, it is fair to assume high-class working conditions, as an enterprise for the sale of power on a large scale would naturally procure the best equipment. When power is to be transmitted electrically, there must be, at the point of delivery, electric motors of the desired capacity, and, at the point where power is available, electric generators of enough greater capacity to make up for losses in line and motors. When very high voltages are employed, it is also necessary to use transformers at the generating and receiving stations, having an aggregate capacity equal to that of motors and generators. A uniform price of $20 per horse power capacity is a low one to assume for generators, motors and transformers. A line to connect the apparatus at the generating and receiving stations must also be provided, whose cost will be determined by the special conditions of each case.

An average commercial efficiency of 90 per cent. for generators and

1. In *Engineering Magazine.*

motors, and of 95 per cent. for transformers, is a fair assumption; the line loss will be determined by the conditions of each case. With these efficiencies and no line loss whatever there can be delivered by motors .90 × .90, or 81 per cent. of the power supplied to the generators, when no transformers are used; or, with transformers, the motors will deliver .90 × .95 × .95 × .90, or 73 per cent. of the power supplied to the generators, with no allowance for line loss, which will of course lessen the efficiencies. A case in which it is necessary to deliver 1,000 horse power a distance of 25 miles may be taken as an illustration. It is desirable to use a pressure of 10,000 volts in this case, for economy of line conductor and transformers would commonly be employed to attain this voltage. Allowing a loss of 10 per cent. in line, there must be supplied to the generator $\frac{1,000}{.90 \times .95 \times .90 \times .95 \times .90}$, or 1,520 horse power, and the generator will deliver 1,520 × .9, or 1,397 horse power. The combined capacities of motors and generator are, therefore, 1,000 + 1,397, or 2,397 horse power; adding an equal amount for transformers, we have a total required capacity of 4,794 horse power, which, at $20 per horse power, has a value of $95,880. To transmit 1,000 horse power at 10,000 volts 100 miles, at a 10 per cent. loss, requires about 168,700 pounds of bare copper wire, which, at 12 cents per pound, has a value of $20,000. The cost of a fair pole line, and the erection of the wire thereon across a country where no special impediments to the work exist, would be approximately $400 per mile, making $10,000 for 25 miles.

Summing up these amounts, we have:

Cost of electrical machinery per delivered horse power.....	$95.88
Cost of wire per delivered horse power.....	20.00
Cost of pole line per delivered horse power.....	10.00
Electrical instruments and accessories per horse power	1.00
Total cost of electrical equipment per horse power.....	$126.88

Allowing 5 per cent. for depreciation and repairs, 3 per cent. for operating expenses, including care of line, and 10 per cent. for interest and dividends, we have a total of 18 per cent. of the original cost ($126.88)—that is, $22.83 per horse power year for transmission expenses.

With well-equipped steam plant, and coal at from $2 to $3 per ton, the cost of steam power may be fairly taken at $25 per horse power year of 312 10-hour days, and $45 per horse power year of 365 20-hour days. The transmission cost of $22.83 per horse power year very nearly equals this cost of steam power; so that, under ordinary conditions, for 312 10-hour days' work power must be delivered to the electric generators absolutely free to warrant its transmission a distance of 25 miles under assumed conditions.

If power is required for 365 20-hour days, about $20 per horse power year may be allowed for the cost of power delivered by motor. As shown above, there must be furnished to the generator 1,520 horse power when 1,000 horse power is delivered by motor—that is, 1.52 horse power furnished for each horse power delivered.

Applying this fact to the last case, it appears that for nearly continuous work, which represents the most advantageous condition for the transmission of cheap power, the maximum price of power at generator for a 25-mile transmission must not reach $20 ÷ 1.52; or $13.33 per horse power year, as the operating expenses of electrical plant are increased by a 20-hour day.

It is certain that, with absolutely free fuel, steam power cannot be generated at less than about $25 per horse power year of 365 20-hour days; so transmitted steam power, from points where fuel is cheap, or even free, is out of the question in the above case.

The cost of water power varies greatly, but it can be procured at some points at less than $13.33 per horse power year, and this would seem to make the 365 20-hour day transmission commercially practical.

Were it thought practical to employ generators and motors of the necessary voltage, thus avoiding the cost of and losses in transformers, the cost of transmission given above could be considerably reduced, and it is probable that many water-power transmissions from 5 to 20 miles can be profitably carried on with such apparatus.

The above is sufficient to show that the electric transmission of power on a commercial basis is limited to much shorter distances than is generally supposed.

If alternating-current generators and motors, to work at 10,000 volts or over, can be obtained, or if a number of continuous current generators and motors are connected in series to attain the desired voltage, the cost of and losses in transformers may be avoided, and the limits over which transmission is practical considerably extended. It is probable that there are many cases where the transmission of moderate amounts of power from 25 to 50 miles is commercially practical with the last-named classes of apparatus.

There are, of course, special cases, as those of mines among the mountains, where the cost of steam is excessive, which will warrant a much larger transmission cost per horse power than that indicated above.

It is sometimes practical to deliver transmitted electric power directly to individual consumers at the receiving station, and thus save the cost of additional generators and motors; this operates to extend the distance over which transmission can be carried on at a profit.

When the transmission of power derived from waterfalls is under consideration, it should be borne in mind that either calculations must be based on the minimum power in the dryest seasons, or else steam power must be supplied to make up the deficiency. This last consideration alone often suffices to render impractical what at first seems a promising opportunity for power transmission.

When the transmission of power from a distance and its distribution for general purposes are under consideration, it should be borne in mind that reliability is the first great requirement of the majority of users. In the early days of electric lighting one of the hardest arguments for the central station manager to answer was that the lamps would and did occasionally go out, in consequence of various accidents to the machinery or line. It is interesting to consider the state of affairs that would exist were a considerable part of New York city deprived of light and power during several hours or a day, while gangs of linemen hurried to some point in the central or western part of the State to repair the supply line, broken, perhaps, by a heavy storm or washout.

Some of the conditions which combine to render electric service from central stations in large cities reliable are duplicate machinery, underground wiring, frequent inspection, and the accessibility of circuits. These conditions are hard to attain in the electric transmission of power for long distances across country, as the interest on duplicate machines would be a considerable sum, underground wiring would be out of the question because of the expense, and overhead lines across country would be damaged by severe storms.

On the score of reliability alone, it seems doubtful whether any plan for the general use of energy transmitted from a great distance would be permanently successful, for a substantial coal pile in the cellar would be far more assuring to the average householder, especially in the winter, than a slender wire exposed for 100 miles or more.

It is very evident, however, that all plans for the transmission of power from great waterfalls, or of power derived from cheap fuel at the mines, with a view to competition with steam power produced in our large cities, are based on a misapprehension of the facts, and can only result in financial disaster, if attempted. The electrical transmission of power can certainly be accomplished over very great distances when expense is no object, but under usual circumstances it cannot compete commercially with that great vehicle of long-distance power transmission—an ordinary coal car.

The Economical Limit of Boiler Pressure for Power Plants.

By W. E. Burgess.[1]

In connection with the increasing tendency toward higher boiler pressures, since the main object is economy in the use of steam in the engine, a consideration of the other station losses, as dependent on the increase of pressure would seem to offer some advantage.

Unfortunately there is little, if any, reliable data for an investigation of this kind and the following is written rather in the hope of exciting someone who possesses the facilities at hand to experiment than for any actual quantitative results that may be obtained.

As steam pressures are increased the steam consumption per indicated horse power per hour is reduced by a quantity which becomes a smaller and smaller percentage at each increase of pressure, and some point must certainly be reached where the losses incident on the increase of pressure in the steam plant considered as a whole must overbalance the saving due to the increase of efficiency of the engines and indeed turn the scale in the other direction. That is to say, any further increase of pressure will produce a falling off in the efficiency of the plant.

The chief losses that increase with the increase of pressure used, are radiation, leakage in the boilers and pipe system, and lessened boiler efficiency; it is also fairly certain that the efficiency of the auxiliary

1. *Electrical Engineering.*

machinery does not increase with that of the main engines, and indeed the losses attendant on this part of the plant are possibly considerably greater at the higher pressure than at the lower ones.

Some few experiments on radiation from steam pipes have from time to time been carried out, generally, however, at low boiler pressures, and the results are so meager that it is impossible to formulate a law from them. At present sufficient evidence has been gathered to more or less establish the fact that radiation losses are not exactly proportional to increases of pressure or of temperature; the curve showing losses in steam pipes due to radiation, at different temperatures of steam, shows a decided tendency to fall off to a lesser inclination at the higher temperatures. We might suggest here that a complete series of experiments on a subject of such importance should certainly have occupied the attention of someone who is in position to successfully carry them out before now, as there is a great lack of experimental information on this matter, especially for high pressures and temperatures. It is a comparative easy matter to do this, and the results would be of very great interest.

Leakage and its variation with boiler pressure is still more obscure; the probabilities are, however, that this will increase more rapidly than the increase of pressure, both from the original leaks and also because of the tendency to form new ones under the higher pressure and temperature. Several curious instances of this have come to the knowledge of the writer during trials that he has made from time to time, both on water-tube and other types of boilers. In one case a water-tube boiler had been built by a well-known firm whose work is beyond criticism, although the results in this particular case were not satisfactory either to the writer or the manufacturers. The boiler was to be used for experimental purposes and was built to carry 250 pounds pressure. The guarantee was that at that pressure there should be no appreciable leakage for twenty-four hours under full pressure, with all connections blanked and sufficient fire to keep the pressure up. At 150 pounds pressure there was some leakage, but nothing more than might be expected; at 250 pounds pressure, however, it was necessary to draw the fires long before the twenty-four hours had expired, due to the loss of water. After carefully overhauling the boiler and re-expanding some of the tubes and carefully grinding all faced joints, putting everything in perfect condition, a second trial was carried out with an almost similar result; the fires had to be drawn long before the twenty-four hours had elapsed, owing to the leakage reducing the water level. This leakage was invisible to a great extent, and it is quite certain that at high pressures steam leaks freely and in such a manner that it is quite impossible to detect it without special care. The usual method pursued by the writer is to hold a small mirror near the supposed leak and thus detect it by the condensation of moisture on the cold surface of the glass. That these small leaks are not unimportant is shown by the fact that in one case a leak from a safety valve, which certainly was not excessive, when caught came to the astonishing amount of nearly 1 per cent. of the total steam used by the engine.

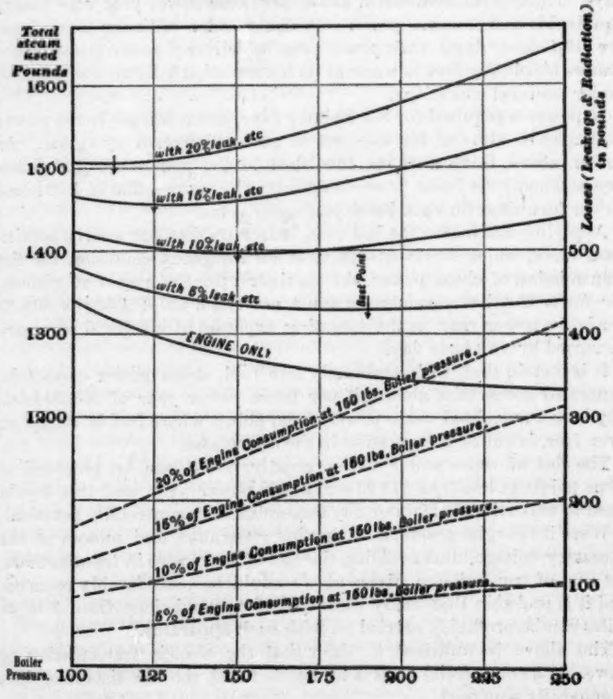
The higher boiler pressures have a tendency to start fresh leaks, and the probabilities are, therefore, that the leakage of the steam system of pipes and boilers is considerably more than directly proportional to the pressure increase. In this way the falling off of the radiation loss from proportionality is more than made up, and the result of combining the two cannot be far from direct proportionality between pressure and loss from all the various sources enumerated.

The subject of reduction of boiler efficiency due to increase of pressure carried is another matter of serious consideration. In the search for information on this point the writer was unable to find anything that could be called definite. There are innumerable trials at different pressures, showing different evaporations and leakages, both included under the head of evaporation, but nothing that could help us in an investigation of this kind. We should like to put in a plea for experiments on these questions also. It would seem a peculiarly easy matter for one of the many engineering colleges to try the effect of the various steam pressures on their boilers and the results would be of great interest to all engineers, who lack to a large extent the time and opportunity to experiment for themselves.

Of course, in this connection considerable saving can be made by the use of economizers, since the heat in the gases escaping at a higher temperature than necessary for draft purposes can thus be utilized for heating the feed water up to a temperaturee as high as 300° F., and it would seem that the loss of efficiency of the higher pressure boilers may be entirely eliminated by the use of these auxiliary appliances. A further study of this problem in connection with their use, and also with the use of superheated steam, might disclose some very interesting facts. At present, however, we will confine ourselves to the problem in hand.

Taking into consideration the fact that the leakage is liable to increase at a greater rate than the steam pressure, and also that the radiation will probably increase more slowly as the pressure increases, we have for the purposes of this article made the assumption that all the losses together would most likely increase directly proportionately to the increase in steam pressure. It is fairly certain that the losses due to radiation and leakage vary in central stations from about 5 per cent. of the steam used by the engines in the best designed and managed plants to as much as 45 per cent. in the worst case known to the writer. It is only fair, however, to state that the latter figure included the steam used by the pumps and mechanical stoker engine. As we have mentioned above, since the law connecting the losses in the boiler and steam pipes due to radiation and leakage with steam pressures has never been ascertained, in the absence of any definite information on this matter we have made the assumption that these losses are proportional to the pressure increase, and it would seem that this is not far from the truth, so that the losses would be represented by the straight lines as shown on Fig. 1.

A loss of 5, 10, 15 and 20 per cent. of the steam used by the engine has been taken at 150 pounds pressure for the purpose of comparison. On the same diagram a curve of total steam consumption has also been platted, showing the actual steam used by the engine at the various pressures considered. This curve, of course, is of such a nature that it gradually tends to the horizontal, so that each increase of steam pressure gives a less saving in steam than the previous increase. By adding these losses at the various boiler pressures to the total steam used by the engine per hour (100-horse power has been taken as the most convenient) a curve of total water used in the station can be plotted showing the total water used per 100-horse power at the various boiler pressures considered. It will be seen from this new set of curves that the steam used per 100-horse power per hour does not now continually decrease with the increased pressures, but owing to the new factor introduced it first comes to a minimum at some definite boiler pressure dependent on the percentage of loss, and then the curve begins to bend up again, and the total amount of steam or water used increases. It will be seen from the curves that, taking the steam consumption of the engine at its best point for each boiler pressure, and consequently a differently proportioned engine for each pressure, it would be inadvisable to use a steam pressure (with a 5 per cent. leakage and radiation loss at 150 pounds) of more than 190 to 200 pounds pressure. With a 10 per cent. loss the best boiler pressure would be about 150 to 160



pounds; with a 15 per cent. loss it will be seen that the best boiler pressure to use would not be more than 125 pounds; and with a 20 per cent. loss the steam pressure at which it would be most economical to work it down to 110 pounds. The engine is taken as triple expansion, condensing.

The curves given do not show the effect of loss of boiler efficiency due to the increased temperatures of the escaping gases, and this would reduce the pressure at which it is economical to run still more. The probabilities are that the limit of pressure, when condensing is somewhere about 180 to 200 pounds, with only the best class of machinery installed, all fittings and pipe work first class and in good working condition. These are considering engine room losses only, and possibly somewhat lower pressures than these would be the limit when boiler efficiency is taken into account.

It is certain that where one or a few large engines are used, and where the piping system is simple and short, as in a mill or factory, a higher pressure can be more advantageously used than when a number of engines are employed with a correspondingly larger and more complex pipe system. Other considerations, however, come into the latter case which completely outweigh the advantage of a few large engines in lighting stations, and these are the variable load factors encountered, and the necessity of arranging the plant in units such that they can be run at practically their point of maximum economy at all times during the day, no matter what the load, by shutting down units as they are no longer required.

From what has been said it will be seen that if reliable loss curves could be obtained for both steam pipes and boilers at various pressures, it would be possible by combination with the engine curve to determine the most economical pressure at which to work under any given set of conditions. It is even possible in some existing stations that the auxiliary losses, due to running at a higher pressure, are sufficient to neutralize the saving due to the earlier cut-off on the main engines. Indeed, only a short time ago, the writer, while in the East, was assured by a presumably intelligent engineer in charge of quite an extensive steam plant, that he had found no saving whatever in fuel by increasing his boiler pressure from 80 to 125 pounds, and that he had tried this for several weeks at a time with no appreciable saving. From this experience he considered himself in a position to assert (and he did it in the gravest manner) that he knew that there was no practical saving in using high pressure steam at any rate above 100 pounds pressure—"He had tried it"—and it did not give the results anticipated. The plant was well loaded down and consisted of Corliss engines. The piping system was somewhat complex and comparatively old, and there is every probability that the station losses increased sufficiently to overbalance any saving due to the main engines.

In conclusion, we can offer this advice to the central station manager or engineer: Look well to the auxiliary losses. Everything saved there is a clear gain, and hardly anything is more neglected as being unimportant.

SPECIAL ENGLISH CORRESPONDENCE.

COMMUNICATED BY NORTON H. HUMPHRYS.

SALISBURY, ENGLAND, December 10th, 1895.

Electric Lighting at Fareham.—The American Gas Light Association.—The Late Mr. Denny Lane.

The history of electric lighting enterprise at Fareham, a small town of some 4,000 or 5,000 inhabitants, is both interesting and instructive. About five years ago an electric lighting company was promoted by a few gentlemen holding prominent public positions in the town. The necessary plant, including poles and overhead wires, was put down, and the company secured the public lighting for a period of three years, and at the expiration of that time, in 1893, they entered upon a second contract. According to the statements of the promoters, they undertook the public lighting at a considerable loss, and looked to the private business as the source of profit. In connection with this admission it should be mentioned that that at the time when the securing of the public lighting contract was in hand, a great point was made of being able to do it as cheaply as the gas company, and the fact that the private consumers would be taxed for this purpose did not then appear. Their expectations with regard to the loss were so far realized in that they have never yet earned a profit, their accounts showing a deficit each year. The public lights were supplied at 3d. per unit, and it was thought that a sufficient number of private consumers, willing to pay 8d. per unit, could be obtained, to admit of covering the loss due to supplying the public lighting at the same cost as gas, and presumably to leave a little balance for the public spirited promoters. After struggling with a losing game for three or four years, for there was very little business in private lighting to be done—there never is in small towns—matters were brought to a climax by the Local Government Board condemning the overhead wires, and ordering them to be put underground. The scrip was at a nominal value, the promoters were not inclined to lay out more money, and shares were offered to the public in auction rooms and elsewhere without securing a single bid. So the next step was to negotiate for the sale of the undertaking as a going concern to the Local Board. Considerable advance was made in this direction, valuers being appointed, and the value of the going concern was assessed at £5,866. As an expert witness put the structural value of the plant at £1,280, it appears that the good will (consisting chiefly of a losing contract) was priced at about £4,500. At this point public feeling became evident in Fareham, and the subject was frequently under discussion during the summer of 1894. The actual completion of the purchase was delayed until after the November election, which was fought mainly upon the electricity question. An extract from the election address of a gentleman who had headed the poll on a previous occasion may be quoted here as furnishing some indication of the state of public feeling. It is as follows:

"The struggle has been gas versus the electric light; heavy battles have been fought; electricity has been in every engagement. The groans and cries of the vanquished will no doubt be pitiful in the extreme. Remember, for years the citizens have writhed in the coils of the directors of the gas companies. You are at last released from such tyranny, and they have only their own overbearing conduct to blame. Therefore pay no attention to their expiring cries, which pollute the air with gas interests."

The eloquence fell short of the mark, for the talented author only got in at the bottom of the poll, his previous position going to a strong opponent of the purchase. Generally the effect was that the promoters of the electric light scheme either failed to secure election, or barely scrambled in. A strong majority against the purchase was elected, and one of the first acts of the new board was to abandon all negotiations with the electric lighting company. But the enterprising gentlemen would not be got rid of in that way. They considered that matters had already advanced so far as to constitute a definite contract to purchase, and called for the fulfilment of the bargain. In default they brought an action in the High Court of Justice, claiming damages of £5,000 for breach of contract. The result has just been declared in favor of the electric light company, on the ground that the present local board could not repudiate any acts of its predecessor, even although such acts might be at variance with the wishes of the majority of the ratepayers. And the Fareham Local Board now had themselves in the unfortunate position of being compelled to purchase the undertaking at the going concern valuation, or in default to pay over the substantial sum of £3,800 as damages, with heavy law costs in either case. So we have not yet reached the last act of the Fareham electric lighting performance.

But the matter is one that will attract considerable attention. The November, 1894, election showed unmistakably the views of the ratepayers. Rightly or wrongly, they did not wish to become the proprietors of the electric light venture. But they are now forced to purchase against their will, under penalty of heavy damages. According to the evidence, everything was perfectly straightforward and fair. What can be done at Fareham can be done elsewhere, and if any local board chooses to run on to a hobby in the way of lighting, draining, water supply or repair of thoroughfares, it appears that the ratepayers are powerless until the next election time comes round. In the space of a few months it is quite possible to incur expenses that practically pledge the rates for years to come, and as much money can be laid out in a day as the ratepayers can pay in twenty years. Clearly, some limit should be put to the expenses that can be incurred without a direct appeal to those who have to pay, and this limit might well run in the same lines as the money raised during the time of office. The people who spend the money should bear the responsibility of finding it. There seems something loose in the idea of a councillor being able to put a heavy debt on the board and then avoid all further trouble or responsibility by simply declining re-election. On the other hand, a new councillor ought not to be tied hand and foot by liabilities which tend to swallow up the whole of his recources.

The innovations that were carried at the last meeting of the American Gaslight Association have attracted some attention here. The progress of Gas Managers Associations in England has always been hampered by a certain kind of caste feeling, with the result that many worthy men, who would and could assist in the objects of such Association, prefer to hold aloof from them. This class prejudice is not the less real because it rarely comes out on the surface. Some object to anything beyond a bona fide gas manager, drawing the line at the "assistant;" others wish to exclude "secretaries," and the amount of discussion that has taken place over the "trader" element is well known. Our general rule in society is to reverence not only official

position, but the probable income, as evidenced by the spending habits. So we are continually hearing of rogues who are welcomed into the best circles of society for the sole reason that they spend money lavishly. How they get it is another thing. In regard to our Gas Managers' Associations, there has been a strong disposition towards measuring a member by the amount of his salary, or the magnitude of the concern under his care. The question of professional training is also in evidence at times. So the small man from the country is made to feel that a lucky coincidence (for him) has caused him to be pitchforked for the time being into the society of his superiors. He soon learns that he must not presume on the privilege of co-membership away from the meeting. And generally that he is supposed to be a cast some way below the recipient of a lordly salary, who has probably enjoyed the advantage of a professional training under a high-class gas engineer. As one of the latter class once put it, "One never knows but what his own engine man might obtain the managership of a small works, and then come and expect to rub shoulders with us." Gentlemen who receive large salaries and dine at aristocratic hours are inclined to be patronizing to the "engineman," forgetting that the latter only despises one thing more than patronage—that is exaggerated effusiveness. Also that the ability to advance the object of the Association cannot be measured in terms of "salary received," or of "tons of coal carbonized." So it will be readily understood that while the majority will cordially approve of Mr. Walton Clark's trenchant utterances, as capable of opening up a new era, there are others to whom they will not be acceptable. Directly we attempt to limit the standing of members by official position, we find ourselves shutting out desirable candidates for membership. Anyone who, for some personal motive or other, desires to be a member, can easily drive a coach and pair through the rules. For instance, the trader in gas apparatus who finds himself refused as such, possibly by men whose patented inventions (on which they receive royalties) are largely advertised, can go and buy a little village gas works right out for a few hundred pounds, and come up smiling at the next meeting as a bona fide gas works manager. This title runs all the way from the man exclusively engaged as such to the one who practically works in another direction, but manages a little gas works as a hobby. So I, for one, would cordially congratulate Mr. Clark upon his hardihood in throwing off the shackles of "official position," and also the Association on its promptitude in accepting his recommendations.

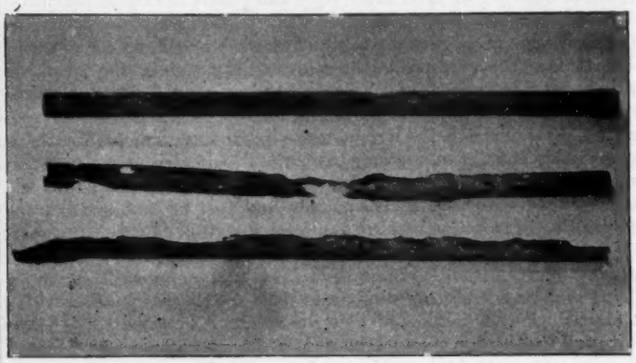
But Mr. Clark's large-heartedness does not stop here. I like his sympathetic references to "those filling subordinate positions at present." Very little has been done in the way of encouraging or assisting the "subordinate" class over here. The government technical examinations and the excellent technical colleges in our principal towns, have in no sense been fostered or aided by our Gas Managers' Associations, but are the result of outside influences. Suggestions have been forthcoming in one way or another, bearing upon the educational duties of an association, as to the encouragement of young members and so on, but nothing further has been done. Perhaps we may follow the example of the American Gas Light Association, and rise clear of class feeling and officialism. In that case our Associations may do some really useful and beneficial work that will leave its mark on the real progress of our industry.

It is somewhat remarkable that my next duty, after the above statements and following close upon them, is a reference to the decease of Mr. Denny Lane, whose official connection with the gas industry was simply that of Secretary of the Cork Gas Company. He was therefore ineligible, according to some ideas, for membership of a Gas Managers' Association. I say his "official connection" advisedly, for his great attainments, his remarkable powers as an orator, and his genial personal character had secured for him a very wide circle of admirers and friends. On two separate occasions he has fitted, with great acceptation, the Presidential chair of the Gas Institute. At other times he has figured as an author of papers. He was well versed in mathematics and natural science, and the statements put forward on behalf of the electric light repeatedly furnished him with opportunities for displaying his exceptionally brilliant controversial powers. Not only had he all the data relating to units of heat, electricity and energy at ready command, but was well skilled in the art of using them so as to convince without bewildering. Added to these, he possessed that peculiar wit which is generally characterized as Irish, and could use it in an unobstrusive and most agreeable manner as a means of illustrating or of clinching his arguments. Further, he had a very intimate acquaintance with literature and the fine arts generally. This unique combination of parts rendered him matchless as a debater, and without being invidious it may be said that, if a prize were offered for the most valuable contributions to the discussions of papers, etc., during the proceedings at the meetings of the last quarter of a century, it would certainly have been awarded to Mr. Denny Lane. Although he had attained the age of 76 years, he attended the meetings in Edinburgh last June, and took such an able and prominent part in them, that the news of his decease will come as a painful surprise to many who hoped that the Gas Institute would have had the benefit of his assistance for many years to come. He was greatly interested in the possibilities of electricity as a lighting agent, and ably advocated the use of gas engines for distributing electricity from small centers, showing that the cost of distributing gas over large areas was very much less than that of distributing electricity. He was a brilliant example of the fact that a Gas Managers' Association may receive valuable aid from one who is not a gas manager. Of him it may well be said, not as a compliment, but as a plain, sober truth, "We ne'er shall look upon his like again."

Electrolysis Up to Date.

Mr. C. F. Prichard, of Lynn, Mass., sends us the following:

The accompanying cut shows what may be done by electrolysis, if carefully and intelligently applied. The pipe was a 2-inch service,



laid within five years, and crossing under two electric railroad tracks in a crowded square. Fortunately the pipe was laid in clay, so the escape of gas was not in proportion to the size of the orifice.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

It is reported that the Spring City Gas Company, of Royersford, Pa., has been leased by J. J. Nix, of that city, for a period of 20 years.

At the next meeting of the City Government of Waltham, Mass., the Aldermen will probably decide that the city purchase the plant of the Waltham Gas Light Company, as the report of the committee appointed to investigate, etc., has been accepted. The order for the purchase must be passed by two successive Boards of Aldermen; must receive the signatures of two Mayors, and must then be passed by a vote of the people. All of which means that it may be some time before the transfer is completed. The plant is valued at $253,000.

Michael C. Jennings has begun suit in the Superior Court against the Mutual Fuel Gas Company, of Chicago, for $20,000 damages for alleged injuries done to himself and his property at the southeast corner of South Chicago avenue and 74th street by the erection of a gasholder.

The Ashtabula (O.) Gas Light Company's plant, which was sold recently at receiver's sale to S. P. Baldwin, of Cleveland, for $5,500, has been sold by him to George W. Wright, of Mercer, Pa., for $28,000. Mr. Wright purchased for an organization which will be incorporated under the laws of Ohio. This property originally cost nearly $50,000. It is making water gas, but will be changed to coal gas.

Supt. W. W. Prichard, of the Portsmouth (O.) Gas and Electric Company, will increase the capacity of the Company's gas department 25 per cent. by the addition of a fourth bench of retorts. More gas is being consumed in Portsmouth this year than ever was known before.

The Philadelphia Gas Company is just completing what is generally considered the largest gas line in the world. It will give them over 1,000 miles of pipe line. The new line is 100 miles long. It penetrates West Virginia, crosses the mountains of that State, and descends into

the gas fields of Tyler and Wetzel counties. Its total cost will be $2,000,000. It consists of a 36-inch pipe laid 4 feet underground, and made of boiler plate steel tubes.

It is reported that the Seattle (Wash.) Gas and Electric Light Company has been sold to a party of Eastern capitalists, headed by Samuel Hill, of Minneapolis. The price paid was close to $1,000,000. The Trustees of the new Company will consist, it is said, of Samuel Hill, W. J. Murphy, W. H. Dunwoody and Horace Henry, of Minneapolis, and H. W. Cannon, of the Chase National Bank, New York.

The Hackensack (N. J.) Gas and Electric Company expects to have its new lines and power house in operation by Jan. 1st, 1896.

James Mulvaney has brought suit for $5,000 damages against Hollinger & Mitchell, contractors, and the Missouri Gas Company, of Kansas City, Mo., for injuries sustained while employed as a laborer on the boiler and engine building of the new gas plant last September. An "insecure" window frame toppled over on Mulvaney and precipated him into a cellar, 10 feet below. He says he sustained severe bruises of the body and a permanent injury of the ankle. In his petition Mulvaney states that he is a skilled coal miner and used to follow that work about four or five months out of the year. The injury to his ankle renders him incompetent as a coal miner, and in view of the fact that he made $4 per day while engaged in that work, he believes he is entitled to $5,000 for his injuries.

At the last meeting of the Common Council of Syracuse, N. Y., Corporation Counsel Ide returned the resolution approving the transfer of franchises of the Gas Light Company of Syracuse to the Syracuse Gas Company, with suggestions of amendment. Alderman Matty included the amendments later in a resolution which was adopted. The features of the amendments were as follows: No sewer, gas or water mains are to be interfered with by the new Company. No pavement nor gutter is to be removed without permission of the Common Council and Commissioner of Public Works, and in such cases where it is removed suitable bonds are to be furnished for its proper replacement. No claims for damages against the city by reason of the permissions given the Company are to be valid. The city is not to be liable to the Gas Company by reason of the negligence of any city officer, interruption of gas transmission on account of improvements, etc. The Common Council will have power to shut off gas transmission when necessary to improvements. The Gas Company will change the grade of pipes and mains when required to by the city.

At a recent meeting of the Chelsea (Mass.) Board of Aldermen, a communication was received from the Mayor vetoing the order for a 3-years' contract, at $26,000, with the local Gas Company, for street lighting. The Mayor stated that he believed the question of the expense of street lighting should be considered with due regard to the needs of other departments, and that nothing should be done that tended to embarrass the next three city governments in making up their annual appropriations. After considerable discussion the order was adopted over the Mayor's veto by a vote of 11 to 4.

The following newsy item has been forwarded by a correspondent: "Because Clinton, Ia., no longer employs gas as an agency in street lighting, that does not indicate that gas is a less important article than in former years. Through the efforts of Mr. S. M. Highlands, General Manager of the Gas Company, during the past year gas has become largely devoted to heating and cooking purposes. Mains have been extended to all parts of the city and practically an entire new coal gas plant of 250,000 cubic feet per day output has been added to the old water gas plant, giving a total daily capacity of 500,000 cubic feet. When oil is reasonable in price water gas is made. When the oil gets too high, coal gas is made. So that that the Clinton Gas Company is now exceptionally provided with facilities for doing cheap and efficient service at any time. The growth of the gas service in Clinton has been wonderful during the past five years. The plant is now the largest in the State, with the single exception of that in Des Moines. There are 18 miles of mains in the city. Four years ago there were only 5 miles, at which time there were only 235 meters in use; now there are 1,300. Five years ago only 50 residences used gas—only one-sixth of the entire consumption; now two-thirds is in dwellings. This shows how popular the use of gas has become in the family. It may also be fairly taken as indicating that our people are improving financially, notwithstanding the hard times. One of the first steps in economy is to shut off gas and use oil or sperm, and one of the first moves in heightened expense when one feels financially easy is to put in and use gas fixtures."

At the recent annual meeting of the stockholders of the Oneida (N. Y.) Gas Light Company, George H. Berry, D. H. Walrath, S. H. Farnham, H. S. Klock and W. E. Northrup were elected Directors. The Directors elected these officers: W. E. Northrup, President; H. S. Klock, Secretary and Treasurer, and A. D. Hamblin, Collector. A dividend of 3 per cent. was declared upon the capital stock.

Mr. Irvin Butterworth, of the Columbus (O.) Gas Company, upon being asked recently what kind of satisfaction the improved outdoor Welsbach gas lights were giving in the streets of Columbus, is reported to have said that he had yet to hear the first complaint. On the contrary, he had been assured by doctors and others of the class of men whose business keeps them out at all hours of the night, that it is a vast improvement over any system of street lighting ever before used in that city. Among the advantages claimed for gas over electricity is the uniform continuity of illumination as against the dark spaces between electric lights, and there are no unsightly poles and cables in the streets. He stated that the city would save $25,000 by lighting the streets by gas instead of by electricity during the ten years called for in the new contract to be let in February. He explained that bids call for electric lighting, but it is understood that if it should be considered a saving to the city it is possible so to change the offer as to admit gas bids. His recollection was that the present contract was let for five years and called for lighting only on dark nights, but the new contract will require lights every night and all night. It is on this basis that his $25,000 saving is figured. The general tenor of Mr. Butterworth's remarks was that it is within the range of possibilities that Columbus may yet be again lighted by gas.

The Alexander Smith & Sons Carpet Company, of Yonkers, N. Y., have placed the contract for their new dye house building with the Berlin Iron Bridge Company, of East Berlin, Conn. The building is 60 feet wide and 172 feet long, the steel roof trusses being arranged to carry cars on the lower chord for moving material about the building.

The Bristol Company, of Bridgeport, Conn., reports satisfactory business for the year in its specialties in recording, pressure gauges, thermometers, voltmeters, ampere meters, watt meters, etc.

At the last meeting of the Board of Aldermen, Buffalo, N. Y., a communication was sent to the Commissioners of Public Works, asking for information as to why the ordinance had not been enforced directing the City Chemist to make semi-monthly tests of the quality of gas which the Companies were supplying to the city. In reply the City Chemist answered that on account of the great amount of work necessary for him to perform for the Board of Health he could not make the semi-monthly tests unless the Common Council gave him another assistant. If the Council would create another office he could make semi-monthly tests. As it was the gas was of such good quality and so far within the specifications that one test a month was sufficient. The test for November showed: Buffalo Gas Company, 18.1 candle power; Mutual Gas Company, 20.5 candle power; Citizens Gas Company, 17.5 candle power. The specifications require 18 candle power within a radius of a mile of the plant, and after that the candle power is reduced proportionately. The test of the Citizens Company's gas was made over a mile away. The answer was deemed satisfactory.

The Commissioners of Washington, D. C., are preparing to make a strong fight for a dollar gas bill to be passed by the present Congress. There will likely be some minor changes made in the new measure from the bill which passed the House last year.

Owing to the fact that the 19th annual meeting of the Western Gas Association will be held in Chattanooga, Tenn., next May, and probably at the hotel on Lookout Mountain, it may be interesting to learn that a new inclined railway has recently been opened from St. Elmo, a suburb of Chattanooga, to the top of Lookout Mountain. The line is a double cable road 4,972 feet long and surmounts an elevation of 1,450 feet. The road is straight but not of uniform grade. The minimum incline is 12 per cent. and the maximum, about 200 feet from the summit, is 68 per cent. The track is laid with 56-pound steel rails, with wooden guard rail, and is rock-ballasted. There are but two rails on the lower half of the incline, the upper half having three rails, with 300 feet of four-rail track at the center for a passing switch. One car has

the flanges of the wheels on the inside and the other on the outside. This device, together with an ingenious arrangement of stationary rail points and guards, causes one car to always take the left-hand track and the other the right-hand track at the switch, and no movable switch is used. The power house is at the summit and contains two 75-horse power engines driving 7½-foot winding drums. There are four band brake wheels on the winding drums and an arrangemegt whereby the car on reaching the upper end of the line sets an emergency brake on the winding drum and cuts off the steam supply to the engines. The engines are worked from an observation house from which the operator can overlook the whole line. There are two 1¼ inch steel cables tested at 104,000 pounds attached to the cars by an equalizing bar. The cars, which are 32 feet long and 8 feet wide, accommodate 50 passengers in swinging seats. They are equipped with signaling devices to the engine room and an automatic safety brake or clutch, which may also be operated by pulling a cord in the car.

OWING to a clerical error in the awards of street lighting in Jersey City, N. J. [see JOURNAL, 23d inst.] the Board of Street and Water Commissioners have since passed a corrected resolution which makes a slight change in the number and price of lights to be furnished by the United Gas Improvement Company, namely, 500 gas lamps at $20.50 per annum each, and 50 at $19.50, instead of 500 at $19.50.

THE Boston News Bureau has from official sources the definition of a good delivery of Bay State gas stock, which is that the old stock, capital $5,000,000, 100,000 shares, green certificates, of the Farmers Loan and Trust Company, of New York, had engraved upon its face: "Capital, $5,000,000." Since the increase of $10,000,000 there has been issued to subscribers 13,900 shares, which makes the total amount issued and listed 113,900 shares. Owing to this change, according to the rules of the New York Stock Exchange, all certificates must be returned to the home transfer agency, the Real Estate Trust Company, of Philadelphia, who issue new certificates, color blue. All blue certificates must be discharged through the Farmers Loan and Trust Company, of New York, when they become a good delivery. Arrangements have been made with the American Loan and Trust Company, of Boston, for a separate registry for Boston, which will be ready in a few days. When ready the blue certificate will be discharged through the Philadelphia office to Boston, and a brown certificate for Boston issued against it.

THE Bangor (Me.) Gas Company has contracted with the proprietors of the Bangor House and the Penobscot Exchange to light these two houses with gas for one year. The landlords were obliged to use gas on account of the utter failure of electric lights to give satisfaction. The gas people say that if they had forty fitters they might use them all on orders at the present time. The gas business is booming and the company is in better shape to handle it than ever before.

THE Selectmen of Rockport (Mass.) have granted a franchise to the Rockport Gas Company. Rockport is a post village of Essex county, Mass., in a small township of the same name, on the Atlantic ocean and on the Gloucester branch of the Eastern Railroad, 36 miles northeast of Boston and about 1 mile west of Cape Ann. It contains seven churches, a national bank, a savings bank, a cotton factory and quarries of granite. Township contains a summer resort named Pigeon Cove. Population about 4,500.

A CORPORATION under the Massachusetts laws has just been granted for the manufacture and sale of gas at Revere and Winthrop. The incorporators include S. Dudley Hannah, of Cambridge, and Mr. George H. Wright, of Newton. The capital is $50,000 and a franchise has already been granted in Revere. Mr. Hannah has been elected President, Arthur B. Carter Vice President, Nathan G. Nickerson Treasurer, and George H. Wright, Clerk. Revere is a post village of Suffolk county, Mass., on Massachusetts Bay, on Eastern Railroad, at the junction of the East Boston branch, and on the Boston, Revere Beach and Lynn Railroad, 4 miles northeast of Boston. Several hotels are at Revere Beach, which is frequented by citizens of Boston on holidays. It is also on the street railroad from Boston to Lynn. Revere post office is a branch of the Boston post office. Population about 2,500. Winthrop is a post village of Suffolk county, Mass., 5 miles northeast of Boston, on the Boston, Winthrop and Point Shirley Railroad. The township is on a peninsula in Massachusetts Bay. Population about 2,800.

THE Malden and Melrose (Mass.) Gas Light Company has purchased an acre of land at the corner of Charles and Commercial streets, for the purpose of extending its plant. The price paid is said to have been $10,000.

THE Natick Gas and Electric Company has asked permission to increase its stock $5,000 for the purpose of making extensions into Wellesley.

THE net price of gas to patrons of the Charlestown Gas Company, after January 1, 1896, will be $1.25 a thousand, bills to be rendered monthly and paid within fifteen days. This company serves all Somerville north of the line of the Lowell road.

IT is stated that the electric railroad at Lausanne is operated from a power house, in which the dynamos are driven by two gas engines of 130 horse power each, built by Crossley Brothers, in England. They use a gas which is made in producers in the power house. The dynamos are run by belt. The working is said to be very economical, and the best results obtained has been an expenditure of 550 grammes (or about 1.21 lbs.) of anthracite coal per horse power hour in ordinary service. The engines are run on an average 18 to 20 hours per day. A careful calculation has shown that the amount of fuel used is 1,300 grammes of anthracite per car kilometer, or about 4.6 lbs. per car mile.

WORK on the buildings and gasholder tank of the new water gas plant of the Bakersfield (Cal.) Gas and Electric Light Company, is rapidly approaching completion. When the new apparatus, which, by the way, is the pattern as furnished by the Western Gas Construction Company, of Fort Wayne, Ind., is in working order, the old coal gas works will be closed down until such time as the price of oil goes up or that of coal comes down, or both.

THE State Department of Pennsylvania has chartered the Pennsylvania Illuminating Company to manufacture and supply gas for light only, to the public within the limits of Allegheny county, excepting Pittsburgh, Allegheny, McKeesport, Braddock and Wilkinsburg. Directors H. McFarland, H. W. Mitchell, William G. Doolittle, of Pittsburgh, and William H. Dood and Charles F. Patterson, of Allegheny City.

The Western Gas Company, of Milwaukee (Wis.), owing to the energy of its general manager, Mr. E. G. Cowdrey, in increasing the sales of gas for fuel purposes, has been enabled to declare a semi-annual dividend of 2½ per cent. The company has this year paid the interest on $3,500,000 of 5 per cent. bonds and a 5 per cent. dividend on the $4,000,000 stock. The latter, which was very low, has nearly reached par. The net earnings for eleven months in 1895 is said to have amounted to $367,623, as against $313,016 for the same period last year.

FOR sometime past the taxpayers of North Attleboro (Mass.) have been discussing, and almost without exception condemning, an action of the trustees of the public library. The town owns and operates its own electric light plant, which is run in connection with its water system. The library has been lighted by the town's electric lights, and the pay for their use was collected from the appropriation made by the town for the maintenance of the public library. The library trustees contended that as the town owned the lights the library shouldn't pay for them out of its appropriation. The town officials say when the town appropriated money for the running of the library for the year it had in mind and incorporated in that appropriation sufficient money to pay for the lights. That it is a correct business principle to have each department pay its legitimate expenses. That the money for lights goes back into the town treasury makes no difference. The trustees contend that pay for the lights in the library should come out of the contingent fund. The town fathers say there is no authority for such action. Thereupon the trustees ordered the electric lights out of the library, and made a contract with the North Attleboro Gas Company to light the library with gas, which has been done.

MESSRS. Humphreys and Glasgow have closed a contract with the St. Joseph (Mo.) Gas and Manufacturing Company for two complete sets of their special water gas apparatus. The plant will have a total capacity of 700,000 cubic feet per day.

ARTICLES of incorporation of the City Gas Company, of Beatrice, Neb., have been filed with the Secretary of State. The incorporators are J. E. Smith, A. S. Maxwell and Fred. J. Maxwell. The articles permit the manufacture and sale of gas, electric light, heat and power. J. E. Smith is the present President and A. S. Maxwell is the present Secretary and Treasurer of the Beatrice (Neb.) Light and Power Company.

THE AMERICAN GAS LIGHT JOURNAL

A. M. CALLENDER & CO.,
PROPRIETORS.

EDITOR - Jos. R. Thomas, C.E.
ASST. EDITOR—T. J. Cunningham.
MANAGER—C. E. Sanderson.

PUBLISHED ON EACH MONDAY OF THE YEAR AT
No. 32 Pine Street, New York.

This is a recognized official organ of
LIGHT, HEAT, STEAM, WATER SUPPLY,
VENTILATION, SANITARY IMPROVEMENT,
AND GENERAL SCIENCE.

TERMS:
SUBSCRIPTION—Three Dollars per annum, in advance. Single copies, 10 Cents.

AGENTS:
New York—American News Co., 39 and 41 Chambers St.
Germany—B. Westermann & Co., of New York.

MONDAY, DECEMBER 30, 1895.

The Market for Gas Securities.

Now that the reasoning faculty seems to have come into play again, that which was a tragedy on Saturday, December 21st, is a farce when looked back upon through the light of Friday, December 27th. The accurate characterization of the market of that famous Saturday is to write it down as having been of the type crazy; for we venture to say that such erratic quotations in stocks of unquestioned merit were never before recorded on the Exchange. For instance, breaks of two to even four points, on computive trades of 100 share lots of Consolidated gas, were recorded oftener than once, which crazy offers were, of course, eagerly taken by the silent anglers who are ever profitably whipping the financial pool. The net loss in Consolidated for the week ended December 21st was 21 points, but the gain for the current week, up to this (Friday) morning, has been sufficient to bring the shares back to a higher level than that made immediately after the date when the market price was 149, ex. div. of 2 per cent. Yesterday, on comparatively light trading (the total sales for the day on the Exchange amounted to 1,825 shares), the high price was 152¼, the low price 150, and the closing was reported at 151 to 153, with the last sale at 151½. However, the scare is well over, and we would condole with those who sacrificed their holdings at 140 and under, were it not for the fact our condolence would not be appreciated by the timid ones just now—neither would it assist them to recover their holdings. Dealers in gas shares ought to remember that there is more of danger to them in the possibilities of skirmishes in the Legislatures of the various States respecting a "horizontal" revision of the gas rates rather than in the perils that lie in a possible war with England or with anyone else. From this we would not have it inferred that we believe the party in power in New York just now is likely to harmfully interfere with the gas industry; on the contrary, we believe it to be not at all improbable that New York will soon have a State Commission somewhat on the lines that have guided so well the interests of the gas consumers and gas companies of Massachusetts. In our belief, which is founded on a sound basis, the stock of every gas company in this city is a purchase for investment at the ruling figures.

Consolidated opened to-day at 150 bid, with sales at 152. Equitable and Mutual are nominally lower, but it would be a difficult matter to secure any important number of shares in either at the reported figures which it is said holders are willing to accept. The Brooklyn Union Company is going along smoothly and cautiously, and the current figures of 77 bid, offered at 80, are to our view nearer to the fair value of its stock than were the considerably higher ones of a fortnight ago. A ripple in the Brooklyn situation comes from the avowed purpose of Lawyer Paul E. De Fere to insist that the Attorney General of the State shall proceed at once to cause the dissolution of what he terms the "Brooklyn Gas Trust." Naturally Mr. De Fere is a little disgruntled just now, through the action of the voters of Kings county at the recent election in refusing to elect him to a judgeship, and while this action would cause in most men a desire to retire from the "public gaze" for a short period at least, it is not so with Mr. De Fere, whose wish is evidently to yet pose before the public eye, despite the blackness of the political one which the aforesaid public administered to himself. The long and the short of it, however, can be sifted to this. The capitalists who formed the Brooklyn Union Company knew to the letter how far they could legally go, and when l'De Fere has had his innings he will have been shown that there are other lawyers just a trifle more expert in the law than is the disciple of the codes who formerly brought up the rear of the Gaynor-Grout combination. In a word, it is big odds on that the legal status of the Brooklyn Company is unimpeachable.

Chicago gas is also well away from the recent scare, and closed yesterday at 66 bid. The proceedings for the rehabilitation of the Company are nearing a satisfactory completion, and its business is expanding in a manner fully justifying the confidence of its controllers. Consumers gas, of Jersey City, is in a very wobbly state, the nominal quotations for it being 80 to 85. Baltimore Consolidated is also weak and uncertain, a fair quotation for it being 58 to 59½. The uncertainty about this stock is the attitude of the Legislature respecting the gas rate; still, as the Senate is at present constituted, we imagine no startling change need be looked for. In this view Baltimore Consolidated looks to be cheap, for at 60 it would yield 8.33 per cent. on the investment. Bay State gas is at 23 to 25, and Lacledes, common and preferred, are quite a bit better than they were a week ago. Western, of Milwaukee, is also stronger. The general market seems to us to be all on the side of the investor, and while it is impossible to say that we are permanently away from "crazy" markets, it is equally certain that those who buy shares in solvent gas properties to day will have reason to congratulate themselves during the last week in December, 1896.

Gas Stocks.

Quotations by Cochran & Close, Brokers and Dealers in Gas Stocks.

35 WALL ST., NEW YORK CITY.

DECEMBER 30.

☞ All communications will receive particular attention.

☞ The following quotations are based on the par value of $100 per share.

N. Y. City Companies.	*Capital.*	*Par.*	*Bid.*	*Asked.*
Consolidated	$35,430,000	100	150	152
Central	500,000	50	150	..
" Scrip	220,000	..	100	.
Equitable	4,000,000	100	200	215
Bonds, 6's	1,000,000	1,000	105	..
" 1st Con. 5's	2,300,000	1,000	114	.
Metropolitan Bonds	658,000	..	108	112
Mutual	3,500,000	100	225	250
" Bonds	1,500,000	1,000	100	102
Municipal Bonds	750,000	..	..	.
Northern	150,000	50	79	80½
" Bonds	150,000	1,000	..	98
New York and East River	5,000,000	100	35	37
Preferred	2,000,000	100	68	73
Bonds 1st 5's	3,500,000	1,000	100½	101½
" 1st Con. 5's	1,500,000	..	90	90¼
Richmond Co., S. I.	348,650	50	50	..
" Bonds	100,000	1,000	..	..
Standard	5,000,000	100	69	72
Preferred	5,000,000	100	106	108
Bonds, 1st Mortgage, 5's	1,500,000	1,000	105	..
Yonkers	299,650	50	112	..
Gas Co's of Brooklyn.				
Brooklyn	2,000,000	25	140	..
Citizens	1,200,000	20	70	..
" S. F. Bonds	920,000	1,000	..	101
Equity	2,000,000	10	..	..
" Bonds	1,000,000	..	..	..
Fulton-Municipal	3,000,000	100	220	..
" Bonds	300,000	..	103	..
Peoples	1,000,000	10	100	.
" Bonds, 7's	368,000	..	100	..
" " 6's	94,000	..	98	100
Metropolitan	870,000	100	200	..
" Bonds, 5's	70,000	..	..	..
Nassau	1,000,000	25	310	..
" Ctfs.	700,000	1,000	99	100
Williamsburgh	1,000,000	50	310	..
" Bonds	1,000,000	..	107	110
Out-of-Town Companies.				
Bay State	5,000,000	50	23	25
" Income Bonds	2,000,000	1,000	..	30
Boston United Gas Co.—				
1st Series S. F. Trust	7,000,000	1,000	78	80
2d " " "	3,000,000	1,000	54	55
Buffalo Mutual	750,000	100	125	..
" Bonds	200,000	1,000	95	100
Central, San Francisco	2,000,000	..	95	..
Chicago Gas Co.	25,000,000	100	66	67
Chicago Gas Lt. & Coke Co.				
Guaranteed Gold Bonds	7,650,000	1,000	94	94¼
Columbus	1,069,000	..	66½	67
1st Mortgage	1,085,000	..	94	95
Consumers, Jersey City	2,000,000	100	80	85
" Bonds	600,000	1,000	100	103
Cincinnati G. & C. Co.	7,000,000	100	203¾	..
Consumers, Toronto	1,600,000	50	184½	187
Capital, Sacramento	500,000	50	..	41
Bonds (6's)	150,000	..	..	..
Consolidated, Baltimore	11,000,000	100	..	61
Mortgage, 6's	3,600,000	..	107	107½
Chesapeake, 1st 6's	1,000,000	..	..	..
Equitable, 1st 6's	910,000	..	..	..
Consolidated, 1st 5's	1,490,000	..	..	..
Detroit	4,000,000	..	..	30
" Con. Bonds	4,312,000	..	71½	75
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1,000	..	101
Fort Wayne	2,000,000	..	..	78
" Bonds	2,000,000	..	..	91
Hartford	750,000	25	130	135
Indianapolis	2,000,000	..	..	145
" Bonds, 6's	2,650,000	..	100	104
Jersey City	750,000	20	180	..
Lafayette Gas Co., Ind.	1,000,000	100	80	85
Bonds	1,000,000	1,000	..	88
Louisville	2,570,000	50	..	130
Laclede, St. Louis	7,500,000	100	20½	21½
Preferred	2,500,000	100	80	..
Bonds	9,084,400	1,000	93½	94
Little Falls, N. Y.	50,000	100	..	100
Bonds	25,000	..	..	100
Montreal, Canada	2,000,000	100	200	.
Newark, N. J., Gas Co.	1,000,000	..	75	.
Bonds, 6's	4,000,000	..	120	..
New Haven	1,000,000	25	225	..
Oakland, Cal.	2,000,000	..	46½	..
" Bonds	750,000	..	..	..
Peoples Gas Lt. & Coke Co., Chicago, 1st Mortgage	2,100,000	1,000	..	108
2d "	2,500,000	1,000	104	105
Peoples, Jersey City	500,000	50	..	175
Paterson, N. J.	.....	25	99	102
Rochester Gas & Elec. Co.	2,150,000	50	..	..
Preferred	2,150,000	50	88	..
Consolidated 5's	2,000,000	..	87½	90
San Francisco, Cal.	10,000,000	100	71½	72
St. Paul Gas Light Co.	1,500,000	100	68½	70
1st Mortgage, 6's	650,000	..	88	90
Extension, 6's	600,000	..	..	..
General Mortgage, 5's	2,400,000	..	88	90
Syracuse, N. Y.	500,000	25	..	..
Washington, D. C.	2,000,000	20	250	..
Western, Milwaukee	4,000,000	100	..	70
Bonds, 5's	3,556,000	..	..	94
Wilmington, Del.	500,000	50	188	190

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1070-8

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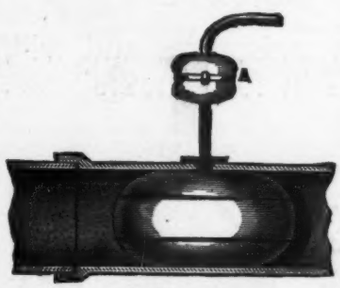

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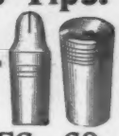

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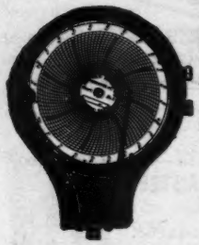

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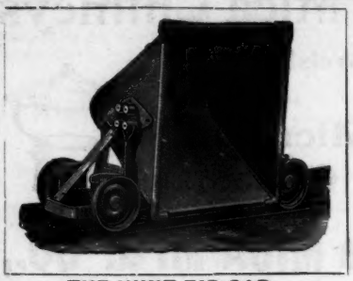

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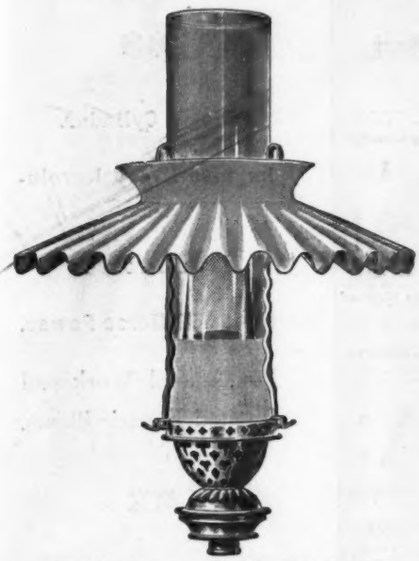

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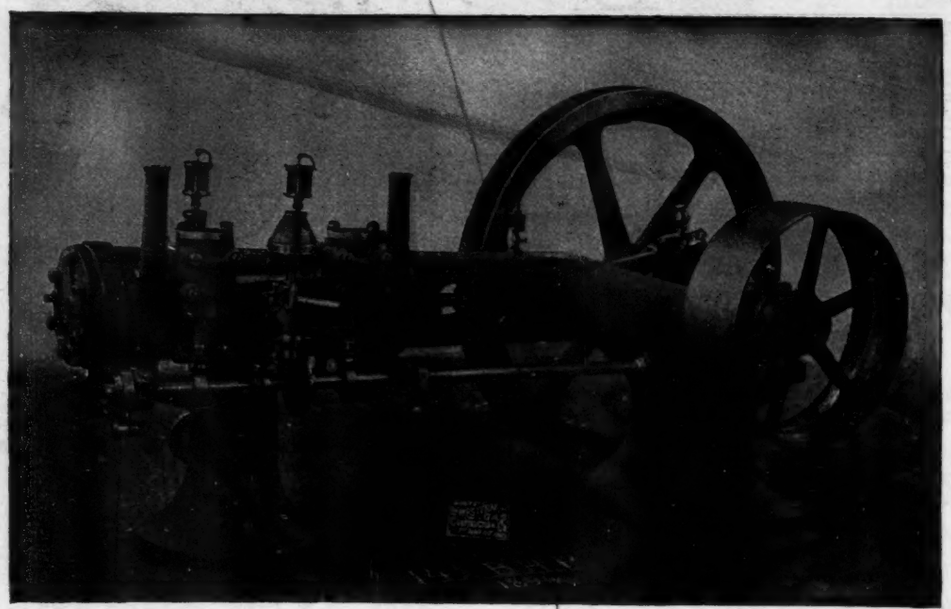

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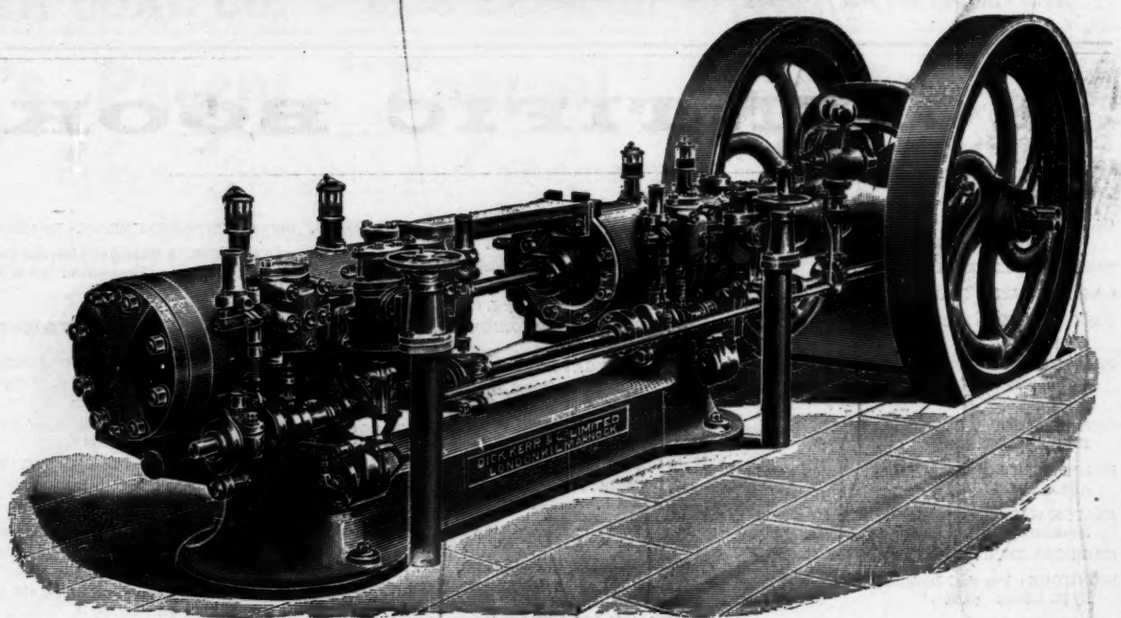

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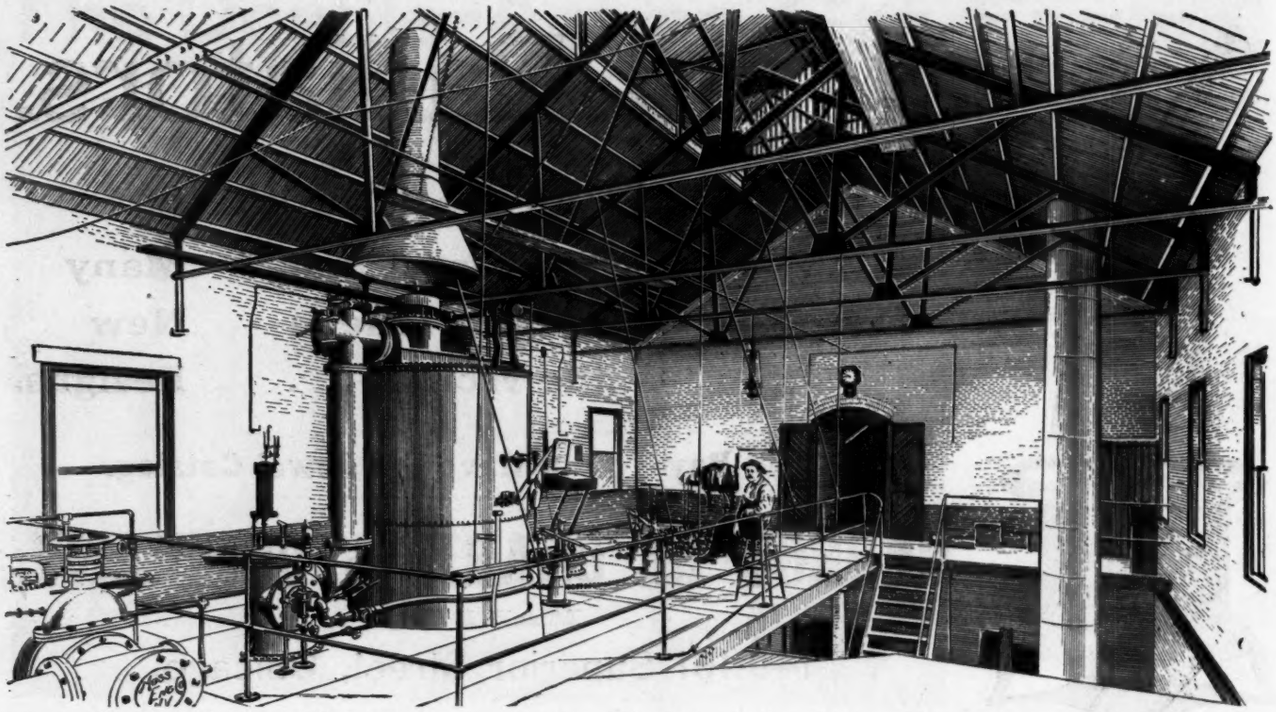

The above illustration is taken from a photograph, and shows the Machine Room of the New Bedford Gas Co., at New Bedford, Mass. The Roof on this building was furnished by us. The building is 32 feet in width by 50 feet in length, the Roof being made entirely of iron—that is, iron trusses and iron purlins covered with corrugated iron. The room is ventilated by a wrought iron ventilator extending the full length of the building, with corrugated shutters on each side opening and closing by cords from the floor.

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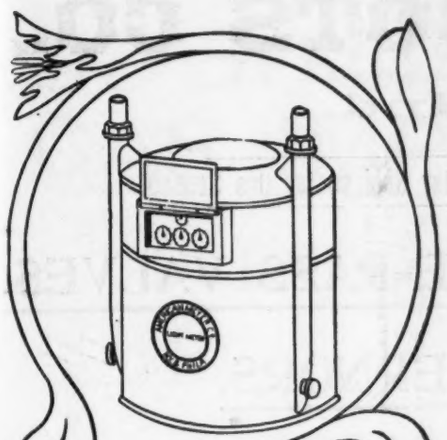

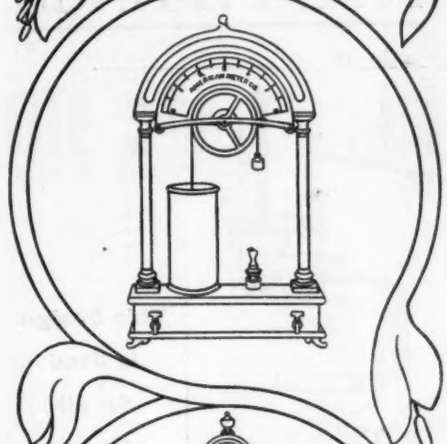

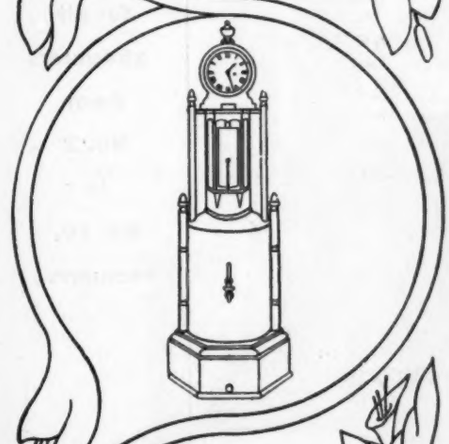

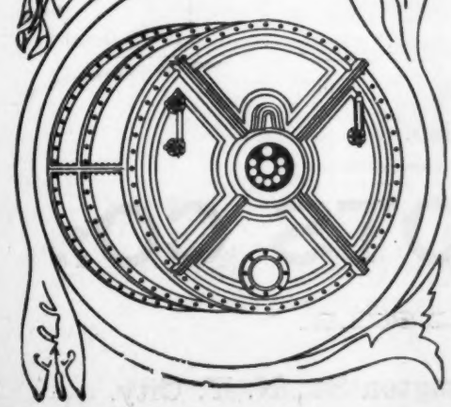

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SAN FRANCISCO.

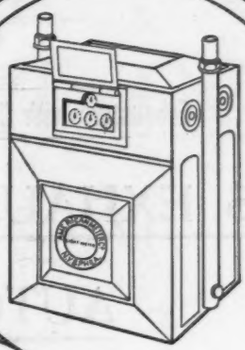
PUBLIC LIGHTING TABLE.

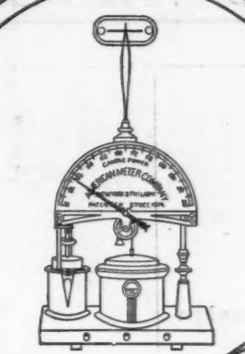
JANUARY, 1896.

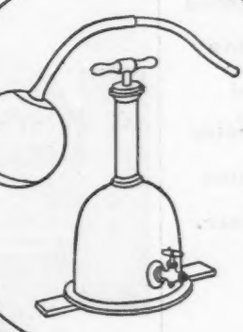
Day of Week.	Date.	Table No. 1. Following the Moon. Light.	Table No. 1. Following the Moon. Extinguish.	Table No. 2. New York City. All Night Lighting. Light.	Table No. 2. New York City. All Night Lighting. Extinguish.
				P.M.	A.M.
Wed.	1	No L.	No L.	4.30	6.30
Thu.	2	5.20 PM	7.50 PM	4.30	6.30
Fri.	3	5 20	9.10	4.30	6.30
Sat.	4	5.20	10.30	4.30	6.30
Sun.	5	5.20	11.40	4.30	6.30
Mon.	6	5.20	12 50 AM	4.30	6.30
Tue.	7	5.20 LQ	2.10	4.30	6.30
Wed.	8	5.20	3.20	4.40	6.30
Thu.	9	5.20	4.30	4.40	6.30
Fri.	10	5.20	5.40	4.40	6.30
Sat.	11	5.20	6.20	4.40	6.30
Sun.	12	5.30	6.20	4.40	6.30
Mon.	13	5.30	6.20	4.40	6.30
Tue.	14	5.30 NM	6.20	4.40	6.30
Wed.	15	5.30	6.20	4.50	6.25
Thu.	16	5.30	6.20	4.50	6.25
Fri.	17	5.30	6.20	4.50	6.25
Sat.	18	5.30	6.20	4.50	6.25
Sun.	19	8.50	6.20	4.50	6.25
Mon.	20	9.50	6.20	4.50	6.25
Tue.	21	10.50	6.20	4.50	6.25
Wed.	22	11.50 FQ	6.20	5.00	6.25
Thu.	23	1.00 AM	6.20	5.00	6.25
Fri.	24	2.00	6.20	5.00	6.25
Sat.	25	3.10	6.20	5.00	6.25
Sun.	26	4.10	6.10	5.00	6.25
Mon.	27	5.10	6.10	5.00	6.25
Tue.	28	No L.	No L.	5.00	6.25
Wed.	29	No L. FM	No L.	5.05	6.15
Thu.	30	No L.	No L.	5.05	6.15
Fri.	31	5.50 PM	8.10 PM	5.05	6.15

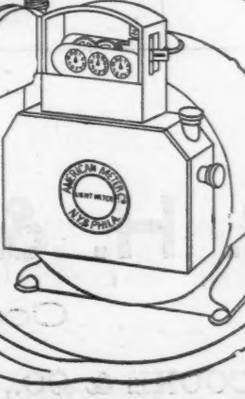
TOTAL HOURS LIGHTING DURING 1896.

By Table No. 1.	Hrs. Min	By Table No. 2.	Hrs. Min.
January	220.40	January	423.20
February	207.00	February	367 40
March	193.00	March	355.35
April	174.10	April	298.50
May	164.00	May	264.50
June	142.10	June	234.25
July	142 10	July	243.45
August	150.50	August	280.25
September	163.00	September	321.15
October	193.10	October	374.30
November	207.00	November	401.40
December	237.30	December	433.45
Total, yr.	2194.40	Total, yr.	4000.00









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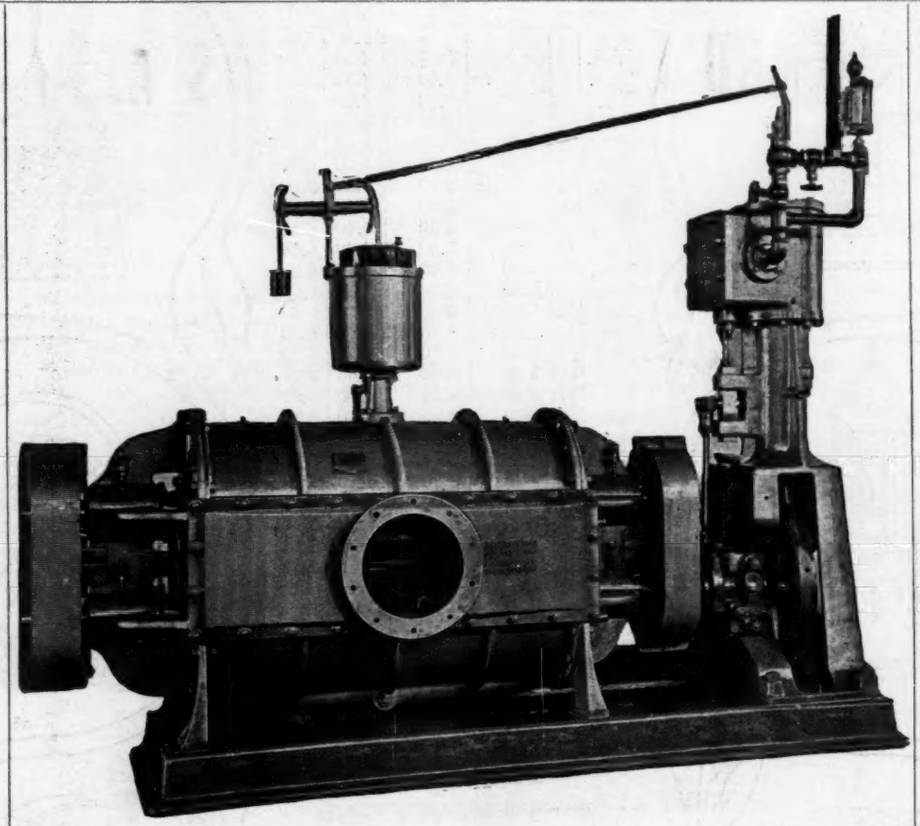

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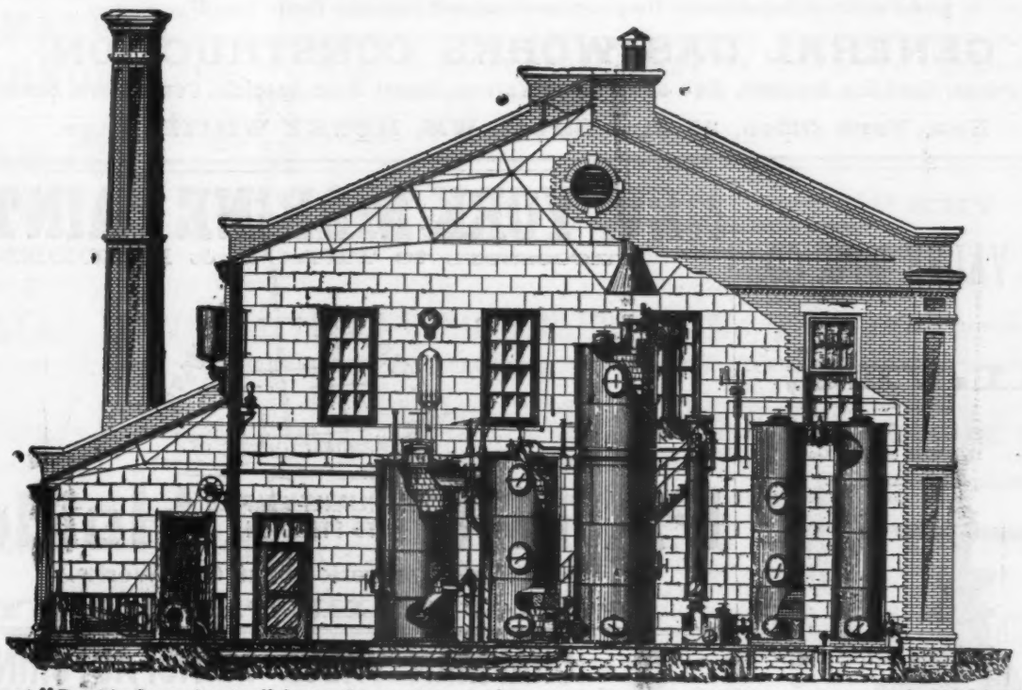

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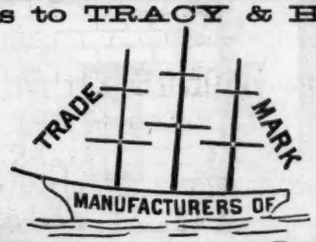

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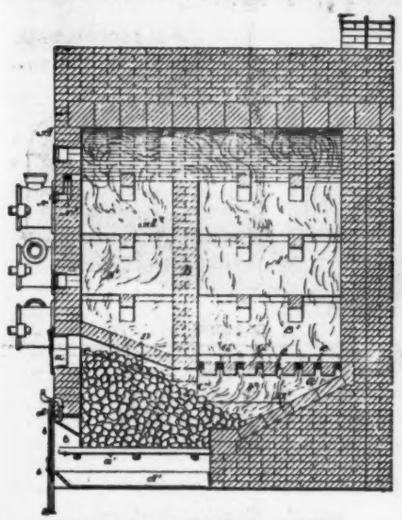

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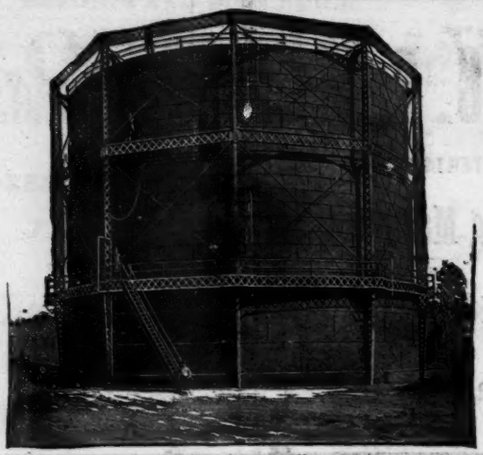

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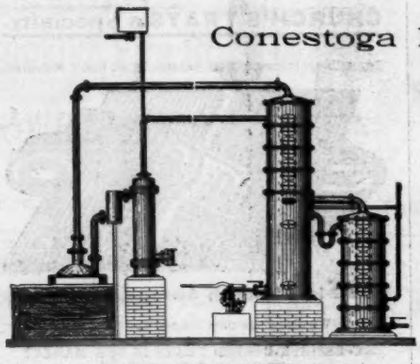

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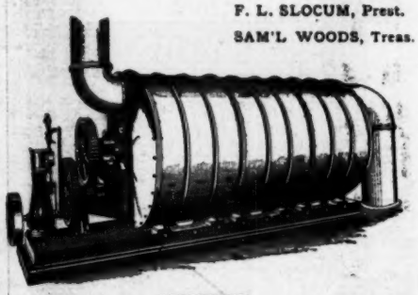

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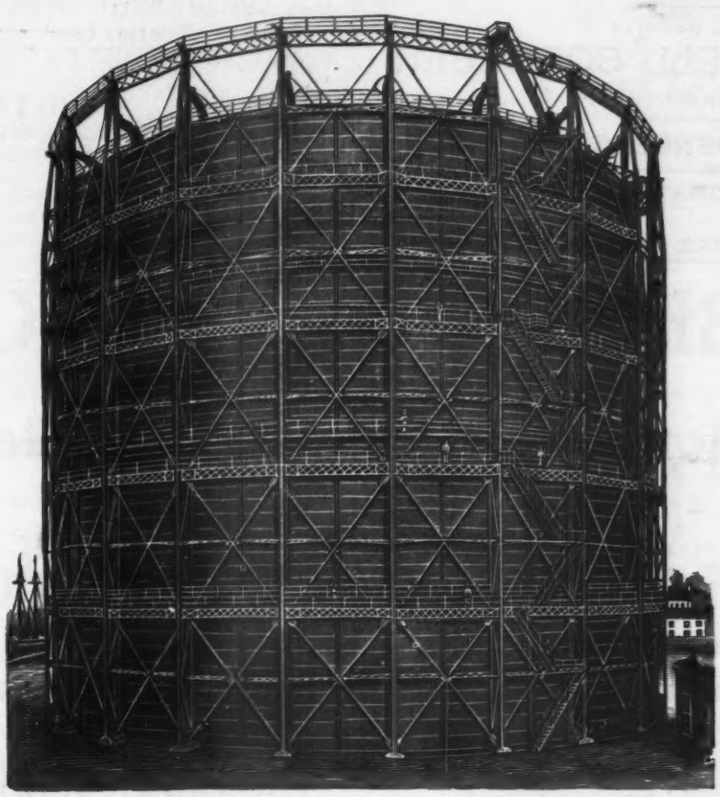

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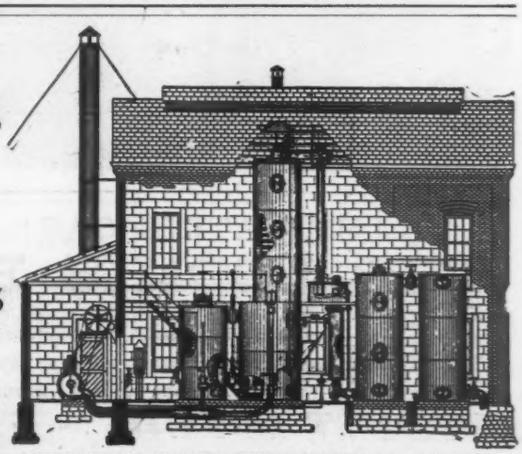

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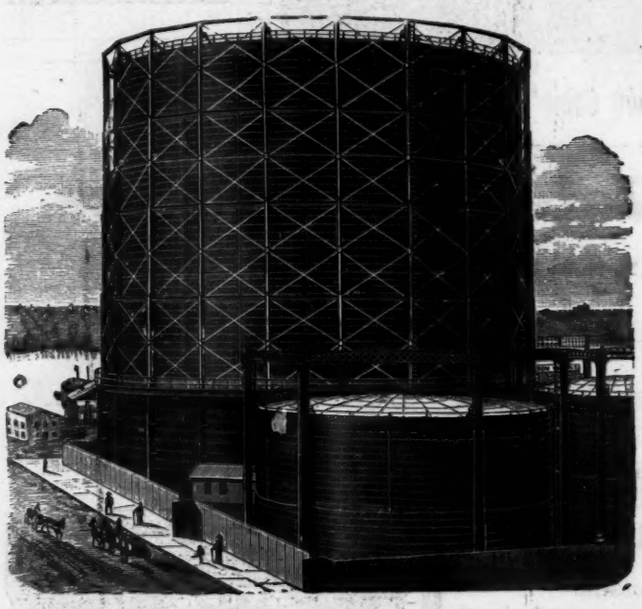

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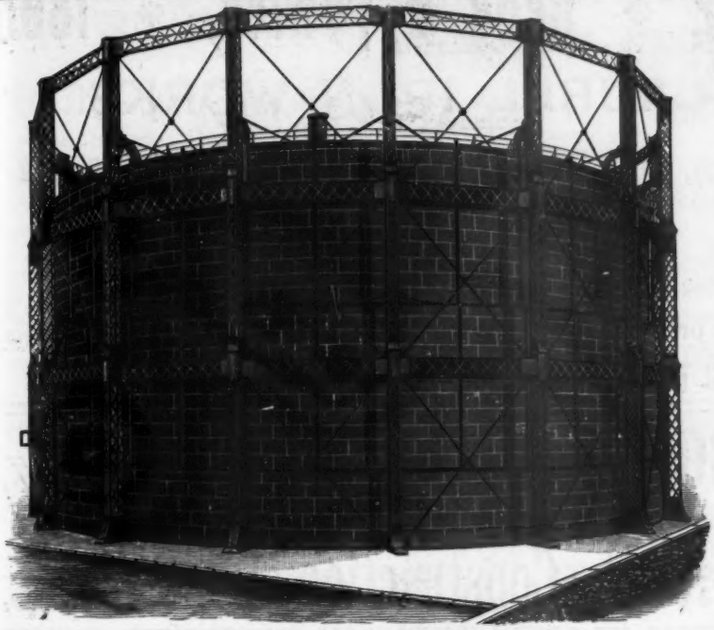

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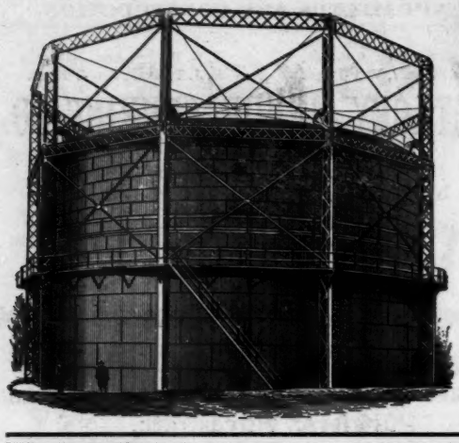

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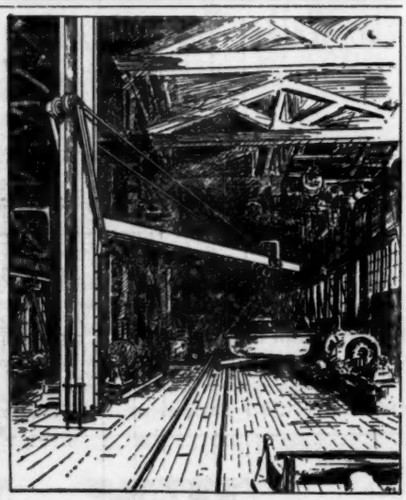

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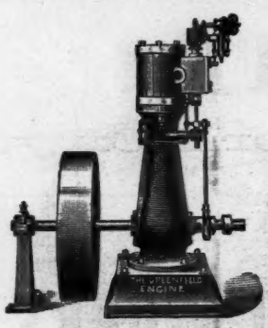

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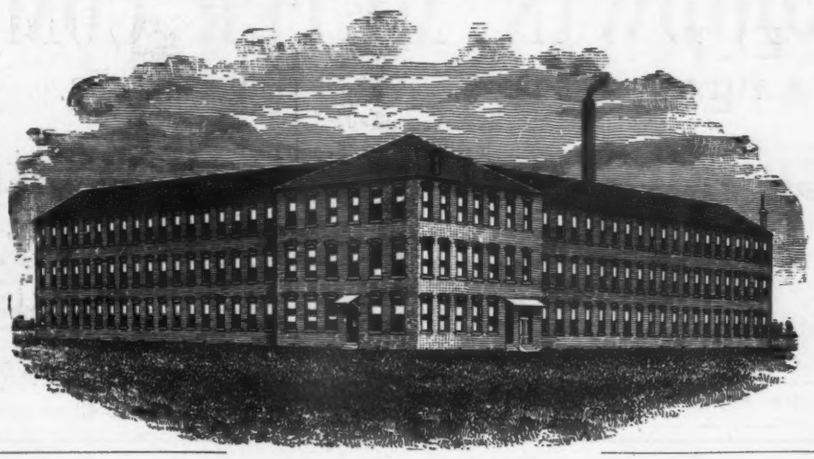

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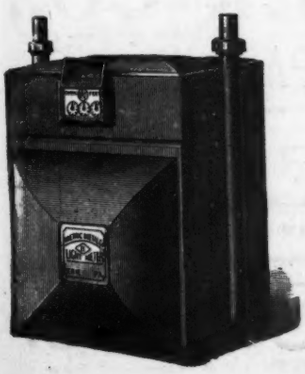

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